VOLUME TWO

HINTS & KINKS

for the Radio Amateur

... A Symposium of the Selected Practical Money-Saving Ideas of 236 Experimenters

Price
50 cents

Published by the AMERICAN RADIO RELAY LEAGUE • West Hartford, Conn.

HINTS & KINKS
for the Radio Amateur

Foreword

THE SUCCESSFUL RADIO AMATEUR is, by very nature, an ingenious fellow. Without a high order of resourcefulness and an ability to improvise he could never overcome the ever-present problem of inadequate work-shop equipment and the equally common handicaps of insufficient apparatus and money. Evidence of this inherent ingenuity is to be seen on all sides. One cannot visit any good amateur station without finding clever improvisations either in the construction of individual components or in the manner in which the whole station is assembled. It may be just a new way to mount a coil or a new scheme for making the antenna do something it never did before. Whatever it is, it is invariably of value to the rest of us.

With the object of putting the best of these "brain storms" into circulation, there has appeared in *QST*, these many years, a department devoted to the general subject of hints and kinks. This department, conducted by George Grammer, has enjoyed great popularity. The ideas contributed to it by ingenious amateurs have helped us all in our search for ways and means to improve our equipment. Unfortunately this garnered gold of amateur experimentation has often been lost to sight, shadowed by some big article or forgotten in the excitement of some major development. Then, too, there has been the annoying business of vaguely remembering a squib on exactly the problem confronting one but being unable to find it when it is most needed. These factors led us, in May, 1933, to publish a collection of the best ideas, schemes and methods offered by *QST* contributors during the three years prior to that date. That first edition of *Hints and Kinks*, reprinted in November, 1933, was well received everywhere. It established definitely the value of a single grouping of selected "experimental expedients" classified and indexed.

The present booklet is a larger and more comprehensive collection of ideas offered by *QST* contributors since 1934. Much of the material has appeared in the Hints and Kinks department of *QST*. Some of it has been gleaned from larger articles where it was doubtless lost to the view of many. Arranged in its present form, the material should constitute a potent help in time of trouble. It should provide the suggestion of many intriguing possibilities for putting back to work abandoned apparatus now gathering dust in the attic. It should, above all, enable us, in one way or another, to improve the functioning of our stations.

We express our thanks to those amateurs whose willingness to contribute the results of their work to the amateur world has made this publication possible.

ROSS A. HULL,
Editor

Volume Two of Publication No. 10 of the American Radio Relay League. *Copyright 1937 by the American Radio Relay League Inc., West Hartford, Conn., U.S.A.* *Printed in U.S.A. First printing, February, 1937.*

PRICE 50 CENTS, POSTPAID

Volume One of this publication, first printed in May, 1933, is now out of print.

HINTS & KINKS
for the Radio Amateur

Contents

VOLUME TWO

Chapter One—**For the Workshop** **5**

Chapter Two—**Ideas for the Receiver** **14**

Chapter Three—**Transmitter Suggestions** **30**

Chapter Four—**Phone Working** **47**

Chapter Five—**Keying, Keying Monitors, Break-In** **60**

Chapter Six—**Frequency Meters, Measurements** **77**

Chapter Seven—**Improving the Power Supply** **87**

Chapter Eight—**The Antenna System** **105**

Chapter Nine—**The Ultra-High Frequencies** **120**

Index **125**

HINTS & KINKS
for the Radio Amateur

1

In the Workshop

Soldering-Iron Outlet

A good many of us use the dollar or dollar-fifty variety of soldering iron; most of them will burn up on ordinary 115-volt house current if left on for any period of time. The diagram of Fig. 1 shows a convenient way to lengthen the life of the iron. A 100-watt lamp, shunted by a s.p.s.t. switch, is connected in series with the socket for the soldering iron plug.

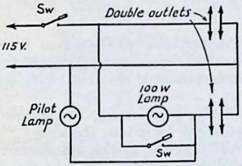


FIG. 1 — HANDY OUTLET BOARD CONNECTIONS, WITH PROVISION FOR REDUCED VOLTAGE ON THE SOLDERING IRON

By closing the switch, the iron may be heated quickly to operating temperature. Then by opening the switch the lamp is put in the circuit and the iron is maintained at a temperature which will keep the solder melted but will not tend to burn up the iron. A lamp of different rating may be used if desired; larger lamps will keep the iron hotter and vice versa.

In my case the lamp, switches and two double outlets are mounted on a board as one unit. The upper double socket is connected directly across the line, providing 115 volts, while the lower outlet not only takes care of the iron but also provides another socket for experimental purposes at reduced voltage. When the shunting switch is closed, four 115-volt outlets are available. The pilot lamp is a precautionary measure against leaving the master switch on unintentionally.

— *Bren Quereau, W5BJ*

Soldering-Iron Holder

The odd pieces of copper tubing usually found in the shack can be used to make a really fine soldering-iron holder. A typical method of using the tubing is shown in Fig. 2. Two or three turns of tubing are fastened to a board at the ends; the iron is pushed between the turns and is held fast when not in use.

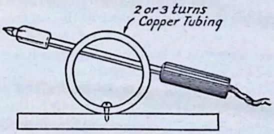


FIG. 2 — A SOLDERING-IRON HOLDER MADE FROM SCRAP COPPER TUBING

A holder of this type dissipates the heat readily, even when the iron is left on for long periods.

— *A. F. Korn, W2AMM*

* * *

Some Coil-Winding Kinks

Here are some suggestions for making wire stay in place on tubing forms.

Those who try to wind heavy wire on an ungrooved form and keep the turns in place know it's quite a tough job. Not everyone has facilities for grooving a form, so here's a method which works well if smooth forms have to be used. The stunt is to wind a coil, just as copper tubing would be wound, on a small-diameter form such as a dry cell. The diameter of the finished coil will be slightly larger than the dry cell because of the "spring" of the wire. The permanent form to be used should be slightly larger than the coil just finished, the difference in diameter depending upon the size of wire used. About one-half inch is satisfactory for No. 8 wire. The end of the coil is forced apart to fit tightly over the form and the rest of the turns forced on by turning the coil on the form. Roughening the form with sandpaper helps make the coil stay in place. — *W2CWT*

W2GEB makes a point of winding space-wound coils when the temperature is high and the wire expanded. Then when the temperature is back to normal the wire contracts and grips the form tightly. Warming the wire in an oven before winding should make the job independent of the weather.

Another method making use of the temperature coefficient of the wire is used by W9HTT. In making the coil the needed length of wire is first measured off and one end attached to a solid support. The other end is fastened to the form and the coil wound by "walking up" the wire. As the wire is wound on, a helper heats it with a blow-torch at a distance of about six inches from the form. On cooling, the contraction sets the turns firmly. W9HTT has wound coils of wire as large as No. 4 by this method and has had no trouble with turns loosening afterward.

Those who want to try unity-coupled circuits will find these hints of interest:

Some of the gang seem to be having trouble threading the grid-coil wire through the plate-coil tubing in unity-coupled outfits. Simply wind the wire to be used for the grid coil around a tube base or other small form so that when the form is removed the coil will be smaller than the plate coil. The wire then will push through the tubing and the end can be caught and pulled through the hole drilled at the center turn. I use No. 20 b.b.e. (braid, braid, enamel) wire. — *W9PHY*

—···—

Making Inductance Clips

It is hard to do a neat job of making small clips to go on tubing, etc., with a pair of pliers. This kink may help.

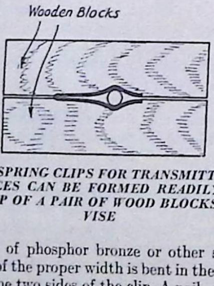


FIG. 3 — SPRING CLIPS FOR TRANSMITTING INDUCTANCES CAN BE FORMED READILY WITH THE HELP OF A PAIR OF WOOD BLOCKS AND A VISE

A strip of phosphor bronze or other suitable material of the proper width is bent in the middle to form the two sides of the clip. A nail or rod of approximately the same diameter as the tubing on which the clip is to work is then inserted between the blades at the point where the bends should occur. The whole is then put in the vise between two small blocks of very hard wood, the nail carefully set at right angles to the length of the material, and the vise screwed home. Fast and neat — and the two halves come opposite each other! The outer lips are then bent back slightly with pliers. A small through bolt may be put about mid-way the length of the clip if necessary. — *K. B. Warner, W1EH*

—···—

A Sure-Fire Inductance Clip

After years of trimming and bending the ordinary type of small clip in an effort to make it serve as a decent terminal for the leads which must be tapped onto small wire wound inductances, I decided to do something about it.

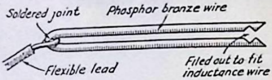


FIG. 4

Accordingly, a bit of No. 19 phosphor bronze spring wire was bent into the shape of a short hairpin as indicated in the illustration, Fig. 4. Before the free ends are brought too close together, they are filed as shown with a small triangular file so that when they are brought together a notch will be provided for the inductance wire to rest in. The flexible wire lead is then soldered to the tail end of the gadget, and at last we have a clip which will permit us to contact our wire wound inductances without shorting out the turn on either side of the one we want. A piece of spaghetti tubing should be slipped over the rear end of the clip to hide the soldered joint and provide insulation.

Possibly the same clip, made of heavier wire, would do for copper tubing coils also. — *Herbert Hollister, W9DRD*

—···—

Tapping Transmitter Coils

A satisfactory method of making taps on heavy wire coils is shown in Fig. 5. A short piece of bare wire, bent as shown, is soldered directly to the turn to be tapped, after the insulation has been scraped off the latter, of course. In soldering, both the bared turn and the tap should be tinned separately and then sweated together without additional solder. This method helps prevent shorting the adjacent turns.

The insulated "clip," the construction of which is also shown in Fig. 5, consists of a jaw taken from a miniature knife switch, the handle being the top of an old binding post. A machine screw of suitable length is first run firmly into the binding-post top, then the head of the screw is clipped off and the assembly fastened to the switch jaw with a small nut. The connecting wire is fastened between the jaw and handle. The resultant clip is positive, easy to handle, has plenty of contact surface and is neat in appearance.

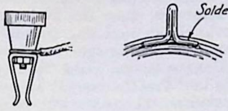


FIG. 5 — DETAILS OF THE INDUCTANCE CLIP CONSTRUCTION AND METHOD OF MAKING COIL TAPS

—…—

A Handy Alcohol Lamp from the Junk Box

THE drawing of Fig. 6 shows the essentials of an alcohol lamp which costs nothing to make, but which nevertheless is a handy gadget to have around the station. Kenneth Ashton, VE5BK, suggested the idea. He writes: "Procure an empty mucilage bottle, the type with the brush inside. Cut off three quarters of an inch of the cap, as indicated in the sketch, make a wick by the use of several folds or layers of cotton cloth, and fill up with alcohol. Methyl hydrate also works well, but *don't* use gasoline! You'll be surprised at the number of jobs this lamp fills where the usual little soldering iron is out."

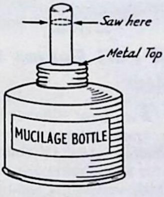


FIG. 6 — ALCOHOL LAMP MADE FROM AN EMPTY MUCILAGE BOTTLE

—…—

Cutting Sheet Aluminum

MOST amateurs at some time or other wish to make an aluminum cabinet and a receiver with plenty of inside shielding. The first question that comes up is that of cutting sheets to the correct sizes without going to the expense of having it done.

The answer is simple — break the aluminum. All the tools that are necessary are cheap and will be found around any amateur shack. Some kind of a sharp tool with which to mark the aluminum and two pieces of angle iron are all that are necessary.

Lay out the aluminum accurately. Then place the piece to be cut between the two pieces of angle iron with the line marked just showing above the angle iron. Clamp this firmly in a vise. Then take a sharp tool — a wood chisel will do the trick nicely — and with a firm pressure run along the line, making a deep cut in the aluminum. Repeat this three or four times. Then, leaving the aluminum in the same position, do the same thing to the other side. This will cut the surface of the metal and allow a clean break to result.

After making several of these deep cuts on each side, grasp the top of the sheet in both hands and work it slowly back and forth, being careful not to bend it too far in either direction. If you do this the aluminum will bend and will not be flat. After bending it back and forth until it breaks take a file and touch up the edges. If care is used in marking off the sheet, it will be the exact size because the aluminum cannot break in any other place except where it is marked.

If several small pieces of aluminum are wanted for brackets the idea is very well adapted for this kind of work. One long piece is first broken and then the small pieces can be broken one after another until the required number is secured. These only need touching up on the edges.

If a very long piece of aluminum is to be broken it will be necessary to place a "C" clamp on the end of the angle iron farthest from the vise. If this is not done the angle iron will tend to spring apart, allowing the aluminum to bend at that end instead of breaking.

Aluminum up to 1/8 inch has been cut by the writer in this style with entirely satisfactory results. Of course the thicker the aluminum the deeper will have to be the marking. It is surprising, though, how small a mark will permit the aluminum to break.

— *P. D. Zurian*

—…—

Cutting Round Holes in Aluminum

WHEN mounting sub-panel or manufacturer's type sockets in an aluminum-shielded receiver, the question comes up, "How can I cut a nice round hole in the sheet for mounting socket, tube, etc.?"

I have solved this in the following manner:

First procure a pair of heavy carpenter's or machinist's dividers and with one leg drill a hole through till the point just comes through. With this as a center adjust the dividers to the radius of the hole desired and scribe a circle. Make several cuts and then turn the panel over and make several cuts on the reverse side. Open a vise just a trifle larger than the diameter scribed, lay the panel over the opening and strike the inside of the circle several blows with the ball end of a ball peen hammer. Turn over and repeat. Keep turning over till you have lost all confidence in this method, then hit it two or three more times and the inside will drop out, leaving a fine hole with no ragged edges.

— Charles M. Conley, W9CXG-W9CLX

—···—

Notes on Machining Aluminum

The increased popularity of aluminum has certainly done much to improve the appearance of amateur apparatus. However, it has often placed a severe strain upon the average amateur's ability as a machinist.

Aluminum does not seem to cut, drill or file like most metals. A drill seems to clog and merely force its way through the work, leaving a bad burr on both sides. The material is so soft that it mars and scratches easily, and though we start with a highly-polished sheet, our finished panel is apt to look like a war relic.

The first trick in avoiding these difficulties is to use a good cutting lubricant. Turpentine is best, but ordinary liquid soap is good. Use a medicine dropper or small oil can and keep plenty of lubricant in the drill hole; if the drill is sharp, the shavings will come out like steel shavings. Dip your file in turpentine and it will cut much more rapidly and will not gum up.

Aluminum's softness presents advantages as well as drawbacks. Large, or irregular shaped holes may be cut with an ordinary jig-saw, just as they might be cut in wood. Use a fine blade and do not force the work. Always use lead or leather covers for vise jaws, or else clamp the work between smooth blocks of soft wood. It is much easier to avoid dents than to remove them!

Avoid using a file on the face of a panel as file scratches are extremely hard to remove. Use a very sharp cold chisel to remove drill burrs or other irregularities.

Holes drilled in the wrong place may be easily filled with Alumweld solder. The only precautions are absolute cleanliness and plenty of heat. Clean the hole with a jeweler's rat tail file and fill it with flux and chips of Alumweld, heating the panel with a blow torch. After filling the hole wash away any excess flux, as it is corrosive. Chip off excess solder with a sharp cold chisel and polish smooth with emery cloth.

The easiest and one of the most distinctive ways of finishing aluminum parts is by sandblasting. This gives a crystalline satin finish, similar to ground glass. If some plant near you has sand blasting equipment, warn the operator to use old sand, only about 30 lb. air pressure, and to work from a considerable distance. This will largely avoid any danger of warping thin parts.

In case you wish a grained finish, start with emery cloth which is coarse enough to remove all dents and scratches. Keep the work wet with liquid soap to cut through any grease films or finger prints. Use increasingly finer grades of emery, finishing with the finest "wet or dry" paper, or with "French emery." If you have sufficient patience, the results will well justify the labor.

Screw heads and other brass parts on the front of the panel may be painted with aluminum paint. However, a much more satisfactory scheme is to have them chromium plated but not polished. Dull chromium plate gives a surprisingly close match to a grained aluminum panel and will last much better than the aluminum paint. Chromium plating of screw heads should cost less than 25 cents per hundred — less than the cost of a can of aluminum paint!

Aluminum may usually be obtained quite cheaply from a dealer in non-ferrous metals. If it is available, it would be well to consider using Duralumin. It is not prohibitively expensive and combines most of the valuable properties of aluminum and mild steel. It cuts like steel, has great strength, weighs but 8% more and costs about 50% more than aluminum. Very often panel thicknesses may be cut in half by using "Dural" with an actual saving in cost and weight.

— S. G. Lutz,
218 Sheetz St., West Lafayette, Ind.

—···—

Threaded Coil Forms for the Transmitter

The most difficult items to construct in a c.c. transmitter, I believe, are the oscillator and doubler coils. Of course, if we are making them for a low-power job which does not require coils with wire larger than No. 18, these coils can be made very easily. However, when we graduate to higher power where the coils have to be wound with No. 14 or larger wire, then the difficulties increase in proportion to the wire size, especially if the coils are space wound.

I have space-wound doubler coils on a two-inch form only to have the spacing change and the turns slip together when the temperature rose and the wire expanded. In fact, it is almost impossible to wind a coil of this diameter with No. 12 or larger wire by hand and get the winding tight enough to stay put.

Threaded forms are the answer to these difficulties, but did you ever take a form to a machinest and ask the cost to have it threaded? To have threaded forms without having to pay a small fortune for them resort was made to the following scheme:

The forms are drilled for the terminals and then given a thin coat of melted paraffine with a small brush. After the paraffine has hardened, the coil is then wound with the exact spacing required. The wire is then unwound and we have a marking on the form in the exact position of the winding.

The form is then placed in a vise and using an edge of a small three-cornered file, a "V"-shaped groove is cut in the form, following the wire marking in the paraffine. When the threading has been completed the paraffine is removed by warming the form in an oven and wiping off the paraffine with a rag.

We now have a threaded form on which the wire can be wound with the assurance that it will stay in place indefinitely. Other means may suggest themselves for marking the form other than using paraffine with equal results.

— H. M. Sheffield

—···—

Kink for Soldering Coil Prongs

Soldering wires in coil form pins is one of those jobs we like least to do, one of the reasons being that it's usually hard to make the solder stick to the pin unless the latter is heated almost to the point where it softens the form, a second being the fact that excess solder and rosin have to be scraped off afterwards. Fig. 7 shows how a simple "alteration" can be made to a soldering iron to simplify the process considerably. A hole about twice the diameter of the pin and about 3/16-inch deep is drilled in the copper point. This is then filled with solder. When coil prongs are to be soldered, the iron is fastened horizontally in a vise, the prongs given just a touch of flux and then dipped in for a second until the solder bites in. The wire should be clipped off rather short, leaving about a sixteenth inch projecting from the pin, before soldering. After the job has cooled a little the excess flux can be wiped off with a rag wet with alcohol.

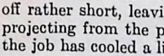


FIG. 7—DRILLING THE SOLDERING IRON FOR SOLDERING COIL PRONGS

One tip — the iron should be big enough so that the solder in the cup will be good and hot. If the iron is too small, a scum will form over the surface and some of it may collect on the outside of the pin.

James Millen — W1HRX

—···—

Dope on Coil Winding

The very practical coils to be described are wound on forms which are removed after the coil is finished, the turns being supported "on air" by strips of celluloid. The winding form may be of ordinary bakelite tubing or wood, the latter being more satisfactory if a great many coils are to be made. One form will suffice for all coils of that particular diameter.

The wooden mandrels should be turned out of maple or other hard wood. A square piece slightly larger than the desired diameter is used. Before it is turned to size, it should be sawed diagonally into two wedge-shaped pieces. Clamp these together and turn them down to size on the lathe. This procedure eliminates the necessity for a shim to make up for the saw cut if the piece is turned first and then cut diagonally afterwards. Round-head wood screws through the thin ends of the pieces hold them together. A length of 8 inches is satisfactory since it is rarely necessary to wind coils that long. If tubing is used, 8 inches is likewise a good length.

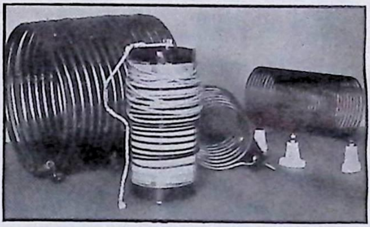


FIG. 8 — DURING THE WINDING PROCESS

This photograph shows the celluloid strips and paper wrappings on a bakelite winding form. Part of the winding has been spaced out with heavy cord.

Several coils made by the method suggested also are shown. The big fellow is six inches in diameter, has sixteen turns of quarter-inch copper tubing, and is as rigid as though it were braced with the old-fashioned longitudinal clamps.

Variety stores carry in their household wares departments two sizes of wooden rolling pins that are "the berries," both for size and cost. These can be cut diagonally in a mitre box.

The materials needed, in addition to the forms, consist of a sheet of celluloid side curtain repair material (from any auto accessory store), some waxed paper, a tube of Duco Household Cement, and of course the wire or copper tubing for the coil.

First cut four strips of celluloid, ½-inch wide and 2 inches longer than the finished coil is to be. Wrap *two* layers of waxed paper on the form, and then one layer of ordinary tablet paper or newspaper over the waxed paper, holding all in place with a tight rubber band at each end. Now slide the celluloid strips under the rubber bands and space them at equal points around the form so that there are four longitudinal "braces."

Run a 6/32 bolt through the form (a ½-inch No. 5 round-head wood screw in the wooden mandrel) at points equal to the intended length of the coil. The 6/32 should be held in place with a nut. Next, secure one end of the wire to one of the bolts or screws and wind on about half the total number of turns close wound, then space out the balance to reach the other bolt or screw at the opposite end. Cut off the wire and secure this end by means of another nut (or by turning down the screw into the wooden form).

Spacing is the next job. This is done by winding a length of chalk line or heavy twine between the turns, starting at the close-wound end. Forcing the twine or cord between the close-wound turns pushes them apart and will close up the wider spacing at the opposite end. Ordinary chalk line will give about 8 turns per inch with No. 12 enameled copper wire, and it naturally follows that if fewer turns per inch are wanted heavier twine or cord must be used. If this method of spacing the turns produces some slack in the last few turns — and it invariably does — take the coil in one hand and hold a fair tension on the winding, then with the other hand turn the form so that the coil acts as a screw working through a thread. This will take out some more slack and a new turn taken around the terminal bolt will hold it tight. When the wire is wound as tightly as possible the spacing cord can be unwound without having the turns of wire slip back together.

The next step is to apply a line of cement from one end of the coil to the other directly over the celluloid. With a toothpick or thin match, press the cement down between the turns so the cement flows out over a good portion of the width of the strip. Another layer of cement can be put on immediately and the same toothpick or match used as a trowel to smooth the cement off and cover the first application. Care should be taken not to apply so much cement that it runs off the strip onto the paper. After all four strips have been treated a third and finishing coat of cement is put on in just the same way as the second coat.

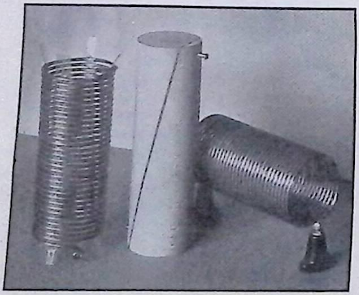


FIG. 9 — THE WOODEN MANDREL SHOWN ABOVE IS CONVENIENT IF MANY COILS ARE TO BE WOUND

A copper tubing coil just as it comes off the winding form is shown at the left; the coil at the right has been "trimmed" and mounted.

Allow the coil to dry over night, or at least eight hours, before attempting to remove the form. This much time is required for the cement to soften the celluloid, shrink it up between the turns and become sufficiently hard to stand "on its own."

To remove the coil from the wooden forms the screws should *all* be taken out; then, with a firm grip on the coil, a slight tap or two on the thin end of one half of the form will loosen it and it can be pulled out from the other end with no effort at all. The bakelite form is not quite as easy to remove, but it can be done by holding the coil in one hand and pulling the form out with a pair of pliers. The *two* layers of waxed paper facilitate removal.

The ends of the strips are easily trimmed off with a knife or scissors. The methods of mounting, several of which are suggested in the photographs, are left to the constructor's preferences.

For 1- or 1½-inch diameters a full-sized piece of celluloid can be used on a piece of mailing tube (the cardboard being torn out on completion of the coil), but the waxed paper idea still holds good when it comes to removing the winding form.

Everything from No. 14 enameled wire up to and including ¼-inch copper tubing can be used, on diameters up to 6 inches, with this method. The builder can feel certain of obtaining a rigid coil with a minimum of "losser" matter, as well as a commercial-looking job that will do justice to the appearance of the rig.

— *A. D. Muldoon*

—…—

Relay Rack Facts

AMATEUR stations of any pretensions usually follow the relay-rack type of construction, and the appearance of even small layouts often can be improved by its adoption. Some of the fellows are having difficulty in finding the dimensions of standard relay racks, however, so here are the figures:

Panel width: 19 inches.
Panel height: multiples of 1¾ inches, less 1/32 inch for clearance.
Rack width: 20 inches.
Clearance between vertical members of rack: 17½ inches.
Mounting holes: spaced alternately ½ inch and 1¼ inches, drilled and tapped for 10-32 screw.
Panel holes: ¼ inch in diameter, centered ⅜ inch in from edge of panel, spaced same as mounting holes in rack.

Panels should be drilled so that the upper and lower edges always will fall just halfway between a pair of mounting holes spaced ½ inch apart.

Plug-In Transmitting Coils

The usual method of mounting copper tubing transmitting coils on G.R.-type wall insulators by flattening and drilling the ends of the tubing is somewhat unsatisfactory in some respects. With the special bushing shown in Fig. 10, flattening and drilling of the coil ends is unnecessary.

The bushing is made of one-inch round brass stock, and is drilled and tapped on one end to fit the 10–32 screw furnished with the insulator. On the opposite end a slightly oversize quarter-inch hole is drilled to a depth of a half inch to make a slip fit for quarter-inch tubing. At right angles to this hole a third hole is drilled and tapped to take a 6–32 screw which acts as a set screw when the coil end is in place.

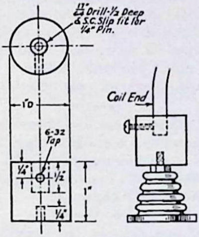


FIG. 10

Using a bushing of this type coils can be changed rapidly and easily, with the certainty of always having good electrical contact.

— *Harold V. Flood, Providence, R. I.*

—···—

Making Neutralizing Condensers

Many amateurs have encountered difficulty in obtaining adequate neutralizing condensers for their high-power transmitters. Either the condensers arced over or the insulation would go up in smoke. The solution of this problem is very simple. Each condenser consists of two rectangular 1½ by 2½-inch aluminum plates. The edges of each plate are well rounded and polished. They are mounted as shown in Fig. 11. Adjustment is secured by rotating the plates about their supporting insulators. The spacing is sufficient to withstand the combined plate and r.f. voltages usually encountered when using Type 852 tubes.

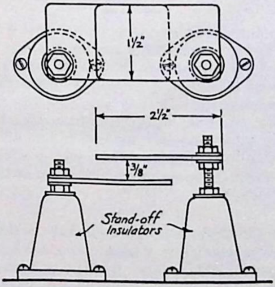


FIG. 11—NEUTRALIZING CONDENSER DETAILS

—···—

A Handy Test Lamp

A useful refinement for the ordinary flashlight lamp and loop so universally used for neutralizing and checking oscillation is illustrated in Fig. 12. The idea originated with T. S. Shaw, W6AVN. A wooden clothespin of the spring type serves as a holder for the usual lamp and wire loop and also as a clip to be snapped on a copper-tubing inductance. The coupling between the loop and the tank coil can be adjusted very readily — and will stay put — if the nose of the clothespin is carved down to a short stub as shown in the drawing. Besides keeping the coupling fixed at the value considered most desirable, both hands are free for the tuning operations.

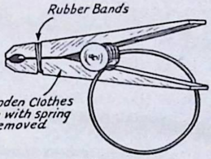


FIG. 12

—···—

Curing Parallax

Users of the National Type B vernier dial should welcome this stunt for eliminating the parallax caused by the fact that the celluloid window on which the indicator line is engraved is some distance from the dial scale. The window furnished with the dial should be removed and a new one, cut from stiff celluloid as shown in Fig. 13, substituted. This has an "extension" which is tapered to a point and bent under, the point riding on the dial scale. For good visibility a little black ink should be put on the point. Be careful of the rivets!

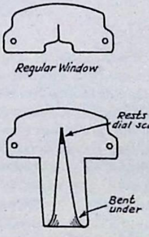


FIG. 13

The scratching noise in the receiver sometimes encountered when this type of dial is used on a metal panel is caused by the brass disc of the dial rubbing against the panel and can be cured by cutting out a disc of celluloid and gluing it to the back of the dial. —*Harry Hurley*

—···—

Leaky Tube Bases

Here is a kink which may help some of the fellows clear up their notes:

I had trouble in getting a p.d.c. note with my transmitter, a self-excited outfit using a single 10 with 800 volts on the plate. I tried everything imaginable but the note was n.d.c. I found out later that r.f. was leaking from the plate to the grid through the base of the tube.

I took the tube out and filed a slot in the base about $\frac{1}{8}$ of an inch wide and about $\frac{3}{16}$-inch deep as shown in Fig. 14. In doing this care must be taken not to file too deeply as one may break the glass tip which is enclosed in the base.

After putting the tube back into service I found that the n.d.c. had disappeared altogether and I got p.d.c., and at times crystal reports. I also noticed that my signal strength increased from an average S6 to S7.

—*Andrew Janiga, Jr., W9HPQ*

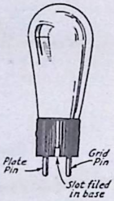


FIG. 14

—···—

Cheap transmitting coil forms can be made from old phonograph records. Boil the record in water until soft, then cut in strips and shape them about a cylinder of the desired diameter. After hardening, the forms can easily be drilled for mounting on stand-off insulators.

—*W9LSN*

—···—

When making plug-in coils on tube bases, if the base is too short for the required winding a piece of an old three-cell flashlight case of the fibre type will just slip over the base, thus extending the available winding length.

—*Ray Howdeshell, Minong, Wis.*

—···—

W4EG makes high-voltage fixed tank condensers from old engraved copper plates and half-inch extensions for loose-leaf binders, all obtainable from engraving establishments. No bolts are needed since one extension screws into the next through a hole bored in the copper plate, and the shoulder of the extension holds each plate firmly in place. The capacity can be made anything desired simply by using enough plates, and final tuning can be done with a very small high-voltage variable condenser connected in parallel.

Fellows using bread cans from the five-and-ten stores for monitors, oscillator shields, etc., will do well to solder the seams in the cans even though they appear to make good electrical connection. A lot of noise can be generated in creaky joints and it might just as well be killed off before it starts. —*W5BSK*

—···—

W2DGU suggests the following method for removing paint from aluminum taken from old auto bodies: Lay the aluminum on a flat surface and cover the entire piece with cloth, preferably wool. Mix equal parts of boiling water and ammonia and add a small handful of washing soda. Soak the cloth with the mixture and let it stand for about an hour. The paint will soften and can be scraped off with a fine-edged tool. Be careful not to apply too much pressure, as the tool will dig into the piece and make unsightly scratches.

—···—

W9FFH finds an old toothbrush handle filed down to work like a screwdriver is FB for adjusting neutralizing condensers, trimmers, and other variables where there is danger of a short-circuit or troublesome body capacity.

—···—

W9NHN constructed an inexpensive and good-looking transmitter rack by purchasing a metal household utility cabinet, substituting a wood panel for the back, and painting with black shoe dye, a non-conductor. These cabinets come in sizes suitable for transmitter racks and have five or six metal shelves. The hinged doors form the back of the rack, and the transmitter is shielded and protected.

—···—

If bakelite rod is not available, celluloid knitting needles, purchasable at any dry-goods store, will make a good substitute. They can be obtained in thicknesses from one-eighth to one-quarter inch.

Dry-goods store also can furnish darning needles, which are a great help in chasing fine wires through the pins in coil forms.

—*T. Bruce Kingsford*

—···—

The turns of transmitting coils wound with No. 14 or larger wire can be spaced quite easily by using a section from one of the old inside spring antennas, if one which fits tightly on the coil form is available. It will slide along as the regular winding is put on, will hold tight enough to give good spacing, and will unscrew or pull off easily after the coil is completed. The spacing coil should have about the same number of turns as the coil to be wound. —*W3AAJ*

—···—

Sponge earphone cushions are just the thing for the fellow who wears glasses. If regular cushions are unobtainable, rubber sponges with holes in them will make a good substitute. —*W3EDG*

A new "solution" for shining up copper tubing is suggested by W8LLI. It consists of a cup of vinegar with three tablespoonfuls of salt. Rub the tubing with the mixture, rinse, and dry; W8LLI guarantees that a fine lustre will result.

* * *

W5PY says that a pair of surgeon's forceps makes a most useful addition to the ham's tool kit. Besides being long and thin enough to get into those almost-inaccessible places, the forceps are provided with a locking catch on the handle by which they can be clamped on the nuts and screws which are forever slipping out of ordinary pliers. Your family doctor probably has an old pair which are rusted and of no value to him.

* * *

W2DPH sends in the following formula to keep the drill lubricated in drilling holes through glass:

Camphor, 1 oz.
Spirits of turpentine, 1½ oz.
Ether, ⅜ oz.

* * *

Inexpensive panels may be made using Prestwood, Masonite building board or similar material. A good crackle finish may be applied by giving the panel one coat of clear Duco or Tri-Seal and allowing it to dry over night. Then spray on a coat of Kem Art Metal Finish, or lay it on thickly with a brush, taking care that the brush marks do not show. Allow this to dry a couple of hours and then bake in a household oven at 225 degrees for 1½ hours. This will produce a regular commercial job. This finish, which comes in several colors, may also be used on metal panels. Both types are produced by the Sherwin-Williams Paint Co. and should be obtainable through any of their dealers. — *W8GVO*

Crackle-finish Masonite is now available in many radio stores. — EDITOR.

"High Power Cement" makes a swell stickum for repairing ceramic standoffs cracked by putting on too much elbow grease when tightening the screws. — *W3AAJ*

* * *

When cheap milliammeters go bad under overload, the trouble is that the small permanent magnet in back of the solenoid has lost its magnetism. The needle no longer goes back to zero but flops loosely all over the scale. To fix it, take the meter apart and take out the small magnet. Wind some cotton-covered wire, about No. 20, around it, starting with one pole and going around to the other; the direction of winding is not important. Then connect the wires to a storage battery for a moment. The magnetism will be restored and the meter will be as good as ever. The calibration should not be seriously affected. — *W2DTE*

* * *

Resistor Color Code

SINCE a good many small resistors are now sold with only color-code identification of resistance value, hams will find a knowledge of the color system used of value. Resistors are marked as follows: The body color represents the first figure of the resistance value; the second figure is given by the color at one end, and the number of ciphers following the first two figures by the color of the dot or band on the body. Figures are represented by the colors given in the table below:

0 — Black
1 — Brown
2 — Red
3 — Orange
4 — Yellow
5 — Green
6 — Blue
7 — Violet
8 — Gray
9 — White

For example, a 75-ohm resistor would have a violet body, green end, and a black dot or band (indicating no ciphers) on the body. Similarly, a 50,000-ohm resistor would have a green body, black end, and orange dot or band (three ciphers following the first two figures).

2

Ideas for the Receiver

Midget Portable Receiver

The circuit of the receiver used at VE4EA will be of interest to anyone planning a portable receiver. The outfit uses two 2-volt tubes and, complete with batteries, fits into an aluminum case measuring only 4½ by 6 by 7 inches. Although the plate voltage is only 13½, the receiver operates well on all frequencies up to at least 25 Mc.

As the diagram shows, the set consists of a regenerative space-charge detector and one stage of audio. The secret lies in the use of the space charge detector, which enables real results to be obtained with low plate voltage.

The space charge idea was tried out a few years ago, but it was not used very extensively because no suitable tubes were available; however, there are several now that seem to be just what the doctor ordered. The 46 and the 49 are examples. Both of these tubes have two grids, but they are not screen-grid tubes; the latter types are not satisfactory because of high plate-to-screen capacity and other reasons (see *Radio Engineering*, Terman).

Now for a few details. The circuit is fairly conventional except for the inner grid in the 49, which has positive bias applied to it to cancel out the space charge to some extent. The outer grid is used as the control grid. The audio stage uses a 30, the filaments of both tubes being connected in parallel. Filament power is obtained from a bank of six No. 2 Unicells in series-parallel to give 3 volts. A fixed resistance drops the voltage to 2 volts. It had been decided to use four cells in parallel for filament supply, but the set didn't oscillate very well with 1½ volts on the filaments, so the series-parallel arrangement was used. Three small-size 4½- volt "C" batteries are used for plate supply and they are strapped in the case wherever they fit. Standard manufactured sets of coils can be used as the tickler turns do not seem to be very critical.

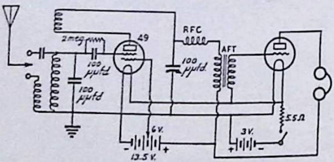


FIG. 1 — SPACE-CHARGE REGENERATIVE DETECTOR IN A LOW-VOLTAGE TWO-TUBE PORTABLE

Regular manufactured coils can be used in the detector circuit, since tickler turns are not critical. Both antenna coil and coupling condenser are used, the former on the lower frequencies and the latter on the higher frequencies, also depending upon the antenna. The coupling condenser need have a capacity of only a few micromicrofarads, and may be made by bending two small pieces of metal strip to face each other, with a spacing of about ⅙th inch between "plates." The audio transformer used by VE4EA has a ratio of 3 to 1.

It was noticed that the ratio of plate to inner grid volatges seemed to be fairly important, and that 13½ and 6 seemed to be best. A bad fringe howl showed up when the plate voltage was reduced, although the tube still would oscillate with 9 volts on the plate. The total plate and inner grid current is 5½ milliamperes and the filament current is .18 ampere, so battery life should be fair. An attempt to control regeneration by varying the inner grid voltage did not work very well, although it represents a possibility. As it is, the usual throttle condenser works satisfactorily except for a slight detuning effect.

— *Roy Usher, VE4EA*

—···—

A Novel D.C. Receiver

The receiver circuit of Fig. 2 is used by John M. Everitt, Ridgewood, N. J., to secure the benefits of the so-called "electron-coupled" or screen-grid feed-back detector circuit, with filament-type tubes. In the original circuit (published in the Experimenter's Section in January, 1933, *QST*) the regeneration tap on the tuned-circuit coil was connected to the cathode of an indirectly-heated type tube; with directly-heated filaments a simple connection to one side of the filament will not work because it is necessary for the whole filament to be above ground for r.f. In Mr. Everitt's circuit this is accomplished by connecting one side of the filament to the tap on the coil and feeding the other through an r.f. choke. This is a thoroughly practical proposition with low filament-current tubes such as those in the 2-volt series.

Naturally the feature of greatest interest in the circuit is the filament choke, RFC_1 in Fig. 2. Of this Mr. Everitt says, ". . . almost anything works at RFC_1 with some success. I have used various cylindrical and bank windings on a piece of half-inch dowel. A choke made of 21 feet of No. 33 s.s.c. wire wound in three separated banks on the dowel seems a little better than anything else I have tried. . . . It makes but little difference if C_9, across the filament, is omitted. Slightly more feedback is necessary with the 34 than with a 58. The rig is at least as sensitive as the 32 or 34 in the conventional hook-up, and the regeneration control is as smooth and definite as on the a.c. model. The 34 seems to be a little better than the 32; with the 34 fringe howl is almost entirely absent. A disproportionate amount of tickler is necessary on the higher-frequency coils, probably because of capacity leakage between the filment choke and the aluminum chassis."

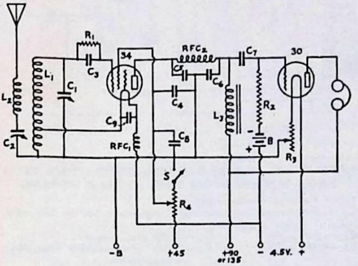


FIG. 2 — RECEIVER CIRCUIT USING 2-VOLT TUBES AND SCREEN-GRID FEEDBACK

C_1 — 135-μμfd. variable.
C_2 — 250-μμfd. variable.
C_3 — 250 μμfd.
C_4 — .004 μfd.
C_5, C_6 — 100 μμfd.
C_7 —.01 μfd.
C_8 — .5 μfd.
C_9 —.006 μfd.
R_1 — 5 megohms.
R_2 — 1 megohm.
R_3 —20-ohm rheostat.
R_4 — 100,000-ohm potentiometer with switch.
B —3-volt flashlight battery.
RFC_1 —See text.
RFC_2 — Any good short-wave choke.

Coil Data

Band	L_1	L_2
14,000 kc.	6 turns tapped at 2nd	3 turns
7000 kc.	13 " " " 1½	5 "
3500 kc.	25 " " " 2nd	10 "
1750 kc.	60 " " " 2½	10 "

The 14,000-kc. coil is wound on a tube base; all others are on regular plug-in forms, diameter 1½ inch. No. 30 d.c.c. wire used for 1750-kc. coil; No. 20 for all others. All coils close-wound.

Bandspreading can be secured by using two variable condensers, one having a maximum capacity of 100 μμfd. and the other 35 μμfd., in parallel in place of the single condenser shown at C_1. In this receiver the filaments are connected in series, and the voltage drop through the 34 detector filament and the choke, RFC_1, is used to bias the Type 30 amplifier. Additional bias is provided by the 3-volt battery in the amplifier grid-return circuit.

—...—

Further Dope on the Tapped-Coil Detector

The following from John M. Everitt, gives further information on the use of two-volt tubes in the version of screen-grid feedback circuit which maintains the screen at ground potential for r.f.:

"Since the tapped-coil detector circuit for d.c. tubes was first suggested and described in *QST*, a number of readers have written to me for further details and suggestions. Most of their troubles were apparently with the filament choke.

"The diagram of Fig. 3 shows a fool-proof method of obtaining the feedback. It is self-explanatory, but I will give the location of the tap for a few representative coils:

Turns in total winding	*Tap, turns from bottom*
3	½
6	1
15	1
30	2⅕
60	3⅕
90	6

If a plate by-pass is used, slightly less turns below the tap should be employed.

"There is no difficulty in reaching 5 meters, but above about 10,000 kc. a Type 32 should be

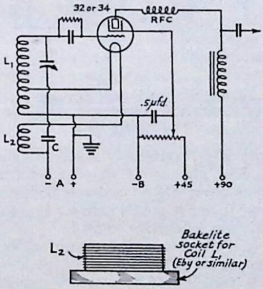


FIG. 3 — DETECTOR CIRCUIT WITH CATHODE TAP AND FIXED FILAMENT COIL FOR USE WITH FILAMENT-TYPE TUBES

Circuit values are usual for regenerative receivers. Data on points at which L_1 should be tapped are given for coils of various sizes in the text. The coil L_2 consists of 10 or 12 turns of small wire (about No. 30) wound around the coil socket, which must be of the type having an extruded top. Condenser C is 0.05 μfd.

used instead of the 34 tube, because of the internally connected suppressor in the latter. On the lower frequencies, however, the 34 gives considerably greater output.

"I have been using the circuit with a stage of t.r.f. and a '30 audio amplifier for some time with very pleasing results."

The chief point of interest in the circuit is of course the fixed coil L_2 in the return filament leg. This coil should be wound in the same direction as L_1, and the lead from the filament should go to the upper terminal of the winding. The voltage induced in L_1 from L keeps the return leg of the filament at the same r.f. potential as the leg connected to the tap on the detector coil.

—...—

Screen-Grid Detector Coupling

Homemade detector couplers using old audio transformers as audio chokes do not always perform as they should; the following letter from Pensyl Mawby, of Trenton, N. J., offers a suggestion which may help in cases where trouble has been encountered:

"I never bought one of those nice, expensive 500-henry chokes used to couple a 35 or 24 detector to a 27 audio; my dollars had to be stretched over too many miles. As per suggestions in *QST* I tried all sorts of old audio transformers, including single stage, p.p. transformers, output audio chokes, etc. with only fair results. I also tried the 250,000-ohm plate resistor without much success.

"In desperation I tried the circuit shown in Fig. 4. The volume was very much better; the sensitivity was marvelously better. English and German b.c. 'phones are easy to listen to and identify as never before (without antenna, only water pipe to one post and radiator to ground).

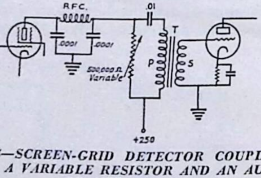


FIG. 4—SCREEN-GRID DETECTOR COUPLING USING A VARIABLE RESISTOR AND AN AUDIO TRANSFORMER

"Maximum sensitivity seems to be reached by using 6 to 8 megs. as detector grid leak and high resistance value in the detector plate circuit. Quality is then not at its best. By reducing the resistance, sensitivity is less, quality is improved and tube noises are less. It is a simple matter to pick up a very weak carrier using a high value and then adjust for best results."

A really good audio transformer — one having large primary inductance — should be used. Mr. Mawby's transformer is a Samson Symphonic.

Improved Regeneration Control for the Screen-Grid Detector

The circuit of Fig. 5 is suggested by Manfred Asson, ES2D, to overcome some of the disadvantages of screen-voltage regeneration control of a screen-grid type detector. As is well known, screen-voltage control tends to cause a frequency change in the circuit and, unless a very good potentiometer is used, is likely to be noisy. Also, since the detector sensitivity is considerably dependent upon a rather critical value of screen voltage, the effective sensitivity is likely to vary considerably if in order to obtain oscillation it is necessary to go very far from this optimum value. This is especially the case when the detector is coupled to the antenna without the benefit of an isolating r.f. stage.

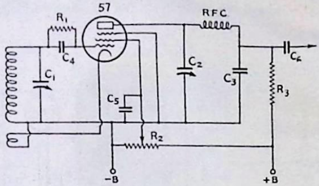


FIG. 5—A NOISELESS REGENERATION CONTROL WHICH DOES NOT AFFECT TUNING

C_1 — *Tuning condenser.*
C_2 — *Regeneration control condenser, 100 to 250 μμfd. max. capacity.*
C_3 — *100 μμfd.*
C_4 — *100 μμfd.*
C_5 — *0.01 μfd., paper.*
C_6 — *0.01 μfd., audio coupling condenser.*
R_1 — *5 megohms.*
R_2 — *50,000-ohm potentiometer.*
R_3 — *Plate coupling resistor, 300,000 ohms (Choke may be substituted).*
RFC — High-frequency r.f. choke.

In ES2D's arrangement the working regeneration control is C_2, a variable by pass across the plate circuit. Screen-voltage is controlled by potentiometer R_2; this serves as an auxiliary control which, once set so that C_2 functions properly, need not be touched. The number of turns on the cathode tickler should be adjusted so that with C_2 at about half scale, the tube will go into oscillation when R_2 puts about 30 volts on the screen grid. ES2D has used this system on 7 and 14 mc., and writes that the regeneration control has no effect on tuning, and is of course noiseless.

—...—

An Effective Regeneration Control

Fig. 6 shows a modification of the ultraudion circuit that I have found very effective as a regeneration control in a t.r.f. receiver. As you will note, the cathode circuit is through an r.f. choke to ground, shunted by a variable condenser. By using a fairly large condenser (350 $\mu\mu$fd.) with a low minimum capacity, regeneration can be controlled from the broadcast band to above 28 megacycles.

The rest of the circuit is conventional. It will be noted that we have retained the 50,000-ohm potentiometer in the screen circuit. This is optional, but useful in maintaining screen voltage at the point which gives greatest detector sensitivity.

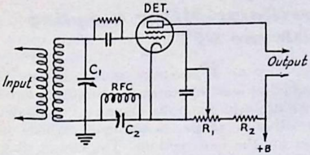


FIG. 6 — MODIFIED ULTRAUDION CIRCUIT FOR CONTROL OF REGENERATION

C_1 is the usual tuning condenser; C_2 the regeneration-control condenser. R_1 is a 50,000-ohm potentiometer, R_2 a 25,000-ohm fixed resistor. RFC is a short-wave type sectional-wound choke.

The advantage of the circuit is the extreme smoothness of control and absence of any tuning effect. — *H. H. Marlin, W9CFG*

—···—

Improving Detector Stability

A NOTE from Griffin Chiles, W5TR, offers what seems to be a good suggestion for freeing the regenerative detector from frequency variations with regeneration-control settings and variations in line voltage:

"The sketch of Fig. 7 shows an improved electron-coupled detector arrangement. The oscillating portions of the circuit (I used a 24-A) are orthodox; the improvement lies in the regeneration control.

"The voltage divider consists of two fixed resistors chosen to meet the following requirements: first, to divide the 'B' voltage so as to provide proper screen voltage; second, to draw sufficient current from the 'B' supply to cause appreciable voltage drop across variable resistor R_3, which is used to control regeneration.

"The voltage divider circuit is incorporated in the detector circuit wiring, and is entirely separate from other voltage dividing equipment.

"It will be seen that this is a true electron-coupled oscillating circuit and, inasmuch as oscillation starts each time with the same voltage applied across R_1–R_2, the calibration is substantially constant. The regeneration control has negligible effect on tuning, and an increase of 20 or 30 volts in the 'B' supply shifts the frequency only slightly. A decrease of course will take the detector out of oscillation, but on reducing R_3 it comes back in on the same frequency. This makes line fluctuations harmless."

If the variable resistor R_3 is 50,000 ohms, a common value, the total resistance of R_1 and R_2 probably should not exceed 50,000 ohms, and preferably should be less for most effective control. Some experimenting with resistor values may be needed for maximum sensitivity and smoothest control. A fair starting point would be to make R_1 about one-fourth the resistance of R_2.

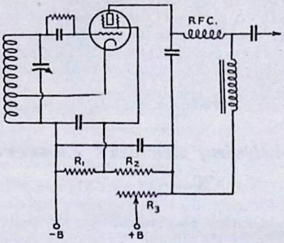


FIG. 7 — IMPROVING DETECTOR STABILITY BY CONTROLLING PLATE AND SCREEN-GRID VOLTAGES SIMULTANEOUSLY

—···—

Increasing I.F. Selectivity by Regeneration

IT IS well known that regeneration in the i.f. amplifier is very effective in improving the selectivity of a superhet receiver. Here is probably the simplest way of introducing the regeneration. It is as effective as any method if control of the selectivity is not necessary.

My own receiver has two stages of i.f. at 450 kc., using 58-type tubes. The first step was to take the first i.f. stage off the gain control and ground the cathode through its 400-ohm bias resistor. Then I took a piece of insulated pushback wire about 4 inches long and twisted one end around the control grid cap. The rest of the wire was then placed next to the tube down inside the tube shield. The grid-plate capacity of the tube was increased enough to make it oscillate. I then cut off about ¼-inch of wire at a time till the tube was just below the oscillation point. It was then necessary to rebalance the i.f. amplifier.

Result — the receiver now tunes about twice as sharply as it did before. The quality of 'phone signals suffers somewhat because of cutting of the side-bands, but as far as I am concerned the width of the ham 'phone bands has been doubled.

It is important that the gain control does not act on the regenerative stage; otherwise the setting of the gain would affect the selectivity.

I believe this little stunt is worthy of a few lines. It is a haywire arrangement, of course, but it certainly does the business — and has the advantage of requiring the purchase of no parts nor the expenditure of any great amount of time. In my particular case I was forced to something like this because the construction of my i.f. transformers is such that it would be very difficult if not impossible to mount a tickler coil next to the grid coil.

— *Earl I. Anderson, W8UD, Douglas, Mich.*

—···—

Stabilizing the 2A7 Converter

THE 2A7 (or 6A7) as a combined oscillator-mixer for high-frequency superhets has made a rather poor reputation for itself from the stability standpoint, particularly because of frequency changes with "B" voltage variations. While the instability is not so bothersome in 'phone reception, it becomes annoying in ordinary c.w. reception and makes satisfactory single-signal c.w. reception extremely difficult.

Wolcott M. Smith, of Springfield, Mass., has suggested the use of neon bulbs in a voltage-stabilizing circuit which maintains practically constant voltage on the oscillator-portion anode despite fairly wide changes in the plate-supply voltage source. The major cause of oscillator instability is thereby eliminated. The circuit, shown in Fig. 8, consists simply of a voltage divider with two neon bulbs in series as one section of the divider. Fig. 8 also shows how plate voltage for the beat oscillator can be taken off the divider in addition to the voltage for the high-frequency oscillator.

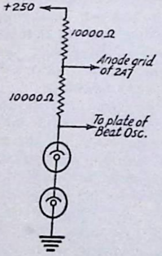


FIG. 8 — NEON-BULB STABILIZING CIRCUIT FOR H.F. SUPERHET OSCILLATOR

The neon bulbs used are the spiral-element type with the series resistors removed.

The neon bulbs should be the new type having a spiral grid as one element. The older type with the small semi-cylindrical plates does not seem to work satisfactorily. The resistor in the base of the lamp must be removed; this can be done quite readily by filing around the base of the shell at the bottom of the threads and unsoldering the center connection.[1] The base then can be taken off and the resistor removed, the wire being soldered directly to the shell. The base may then be replaced, the center connection re-soldered, and some solder run around the filed part of the shell to keep the base in place.

—···—

Oscillator-Mixer Coupling with the 6F7

PROBABLY most amateurs know the 6F7 at least by name. It consists of two separate tubes in one bulb, one an r.f. pentode and the other a triode, a common cathode being used for the two sections. The circuit diagram of Fig. 9 shows a method of using the tube as a combined mixer-oscillator in superhet receivers, the point of interest being the method of coupling between oscillator and mixer sections. This arrangement is suggested by B. P. Hansen, W9KNZ, who has found it superior on many counts to coupling circuits previously tried.

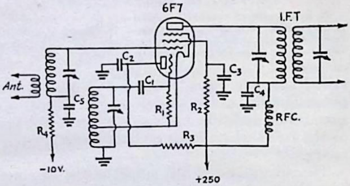


FIG. 9 — CATHODE OSCILLATOR-MIXER COUPLING FOR THE 6F7

C_1 — 500-μμfd. mica.
C_2 to C_5, inc. — 0.1-μfd. paper.
R_1, R_2 — 100,000 ohms.
R_3 — 50,000 ohms.
R_4 — 250,000 ohms.
RFC — 60-millihenry r.f. choke.
Tuned circuit constants usual for the type of tuning system employed.

W9KNZ writes: "This is the stablest and quietest converter circuit I have tried so far, and I don't exaggerate when I say I've tried more than a couple. The cathode of the tube is placed above ground by the r.f. drop across the portion of the oscillator coil between cathode tap and ground, and since the cathodes of the two sections of the tube are the same the mixer cathode will also be above ground by this voltage. This means that the r.f. drop appearing across this section of the oscillator coil also will be applied to the mixer grid. There may be regeneration in the mixer, too, although this stage is perfectly stable. The conversion gain seems to be rather higher than with the more common layouts, while the noise level is lower than on anything so far tried here. Stability is swell — probably the grounded-plate oscillator has something to do with that. Also, while the coupling is certainly direct enough, there is freedom from the usual 'pulling' so common with electron-stream coupled mixing circuits. The r.f. circuits must be shielded from each other. The r.f. filtering shown might perhaps be dispensed with, but the receiver I'm using it in is rather cramped."

---

[1] Neon bulbs without the resistor in the base are now available. They are equipped with auto-headlight type bases to distinguish them from the regular candelabra-base lamps provided with series resistors.

A later letter from W9KNZ indicates that the circuit will handle large signals a bit better if automatic bias instead of fixed bias is used on the mixer section. The proper automatic bias can be secured by inserting a 1700-ohm resistor, bypassed by a 0.1-μfd. condenser, in series with the connection from the lower end of the oscillator coil to ground.

—···—

Improving Selectivity in the Regenerative Receiver

In view of the great interest in noise and QRM reducing circuits the details of a receiver used here may be of value.

The second a.f. of the simple 1V2 receiver (see Fig. 10) may be an old tube working as a limiter by adjusting its plate voltage. Now all signals and QRM have practically the same QRK. That alone helps, but the following peak tube improves it still more. In its plate is the headphone, and a variable mica condenser, C_1, feeds back to the plate of the limiter tube. Therefore a coupling transformer is used and connected so that it feeds back. Two condensers, C_2 and C_3, are switched across the transformer secondary to tune to about 1000 and 100 cycles. The switch also places an additional capacity C_4 in parallel to C_1 for 100 cycles, as a greater value on this frequency is necessary. Once the feedback condenser C_1 is adjusted to a point just before oscillation it need not again be touched. The transformer primary has across it a resistor of about 10,000 ohms as a constant load to prevent changing the feed-back condenser at various limiter tube settings.

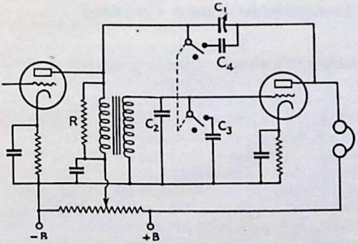


FIG. 10 — VOLUME LIMITER AND REGENERATIVE AUDIO AMPLIFIER FOR REDUCING NOISE AND INCREASING SELECTIVITY IN C.W. RECEPTION

The values of the condensers marked must be determined by experiment. The values of the "tone" condensers, C_2 and C_3, will depend upon the constants of the audio transformer used; values in the usual range of mica condensers — .0001 to .002 μfd. — should give a satisfactory result with most transformers. The feedback condensers, C_1 and C_4, likewise must be adjusted experimentally to give satisfactory regeneration with the tube and plate voltage employed.

If you want to simplify the circuit and prevent connecting the large feedback condenser for 100 cycles, use the larger capacity in parallel to the transformer secondary alone for the low peak frequency. Don't use too great plate voltage on the peak tube or your ear drum gets hot at adjusting the feedback condenser!

Last but not least a separate h.f. oscillator is important for such strong QRM signals as would block the detector. Now, for example, an S9 interference and a wanted S4 signal are first limited until both are the same strength, and after passing the peak stage the interference can be S3 to S5 and the signal S9. Often the difference between wanted signal and interfering signal is only 100 cycles or less; then use the low pitched peak and the signals are still readable until both sigs have the same frequency, where there is no help of course. The same goes for auto and static QRM where either the 1000- or 100-cycle peak may be found best. — *Hans. H. Plisch, OK2AK*

—···—

Calibrated Band-Spread and General Coverage with the Same Coil

The idea diagrammed in Fig. 11 is suggested by Thomas C. Moore, VE3AFT. The circuit shown is particularly adapted to a super-

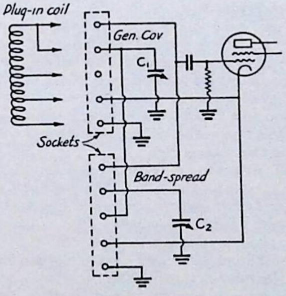


FIG. 11 — WITH THIS CIRCUIT, EITHER GENERAL COVERAGE OR FULL SPREAD OF AN AMATEUR BAND CAN BE OBTAINED ON THE SAME COIL WITHOUT RESETTING A VARIABLE CONDENSER

C_1 is the tuning condenser (100 to 140 $\mu\mu$fd. maximum capacity). C_2, a screwdriver adjusted air padder, is the band-setting condenser which is adjusted only once. Band-spread or general coverage is obtained by shifting the coil from one socket to the other.

het oscillator when used with a separately-tuned first detector circuit, in which case the rather uncritical tuning of that circuit makes band-spread unnecessary. Two coil sockets are used, with the wiring arranged so that when the coil is plugged in the "general coverage" socket the tuning condenser, C_1, is connected across the whole coil. In the "band-spread" socket, the padder, C_2, is connected across the coil, while the tuning condenser is connected across a number of turns which will spread the particular band satisfactorily. In practice C_2 is set to bring the band on C_1 when the coil is in the band-spread socket; no further adjustments are necessary when going to general coverage. The advantage of this system is that both the band-spread and general coverage ranges can be calibrated, since the business of returning a band-setting condenser to a predetermined point to hit the band is eliminated, along with errors in setting.

The same idea can be applied to the regular regenerative detector circuit by making provision for antenna coupling. The antenna might be connected directly to the cathode tap, or, if six-prong forms are used, the extra pin could be used for the antenna connection of a separate coupling coil, the other end of the coil being returned to the ground pin. Also, the same method can be readily applied to r.f. coils in the set.

—…—

Calibrating the Receiver for General Coverage

On finishing the construction of a receiver using the parallel-condenser method of band-spreading, with the band-spreading condenser across only a part of the coil on the higher frequency bands, the following method was used to lay out calibration curves for each set of coils. Such a calibration is useful in locating commercial and b.c. stations of known frequency, and also as a guide to band-spread tuning across the whole range without overlapping and without missing any frequencies.

First, with the band-spread dial at zero, tune across the whole range with the band-setting or tank condenser and get a series of readings from signals of known frequencies. Plot a curve for these. Then set the band-spread dial at 100, repeat this operation, and plot a second curve. Then the intersections of the two curves with a vertical line at any particular location (corresponding to any particular setting of tank condenser dial) will show the range of frequencies that can be covered by the band-spreading condenser for that particular setting of tank condenser. A typical curve is shown in Fig. 12.

To get the proper settings of the tank condenser to cover the whole range on band spread, start with some particular setting — say the setting used for the ham band — and mark a vertical line. The point where it intersects upper curve will be highest frequency for this setting. Then follow across horizontally on this frequency to the lower curve and this will be the next setting of tank condenser (set dial at next lower figure to give slight overlap). Continue this over the whole range, marking the tank condenser settings necessary to give complete coverage.

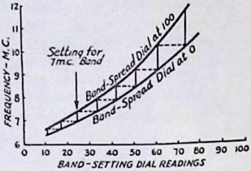


FIG. 12

If a low-frequency oscillator is available, the calibration can be made in a very short time. Set oscillator by some b.c. station and get a series of calibration points from its harmonics.

For ordinary use, the approximate setting of band-spreading condenser in order to tune in a station of known frequency can be estimated near enough by noting the position of this frequency on the vertical line between the two curves, but if greater accuracy is wanted, a few more points could be obtained, for other settings of band-spreading dial, say for 20, 40, 60 and 80, and additional curves drawn through these points.

— H. S. Britt, W7CQE

—…—

Automatic Tone Control

The utility of a tone control for cutting off high audio-frequency noises in amateur receivers is generally recognized. The type of tone control customarily used is that which attenuates high frequencies only. Also useful under certain conditions, particularly in voice work, is a control attenuating the lower audio frequencies, leaving only the most useful center or "communication band" of frequencies in the output. Interference of the variety that can be cured in a.f. circuits is largely inversely proportional to signal strength; i.e., tone controls are usually needed only on weak signals, with correspondingly less need on strong signals.

An automatic tone control providing both bass and treble attenuation proportionately to signal strength is shown in Fig. 13. A 6C5 is used as the automatic tone control tube (either a 56 or 76 could be substituted, with a change in the cathode bias resistor as indicated). The grid of this tube is tied into the a.v.c. circuit by means of a potentiometer enabling adjustment of operating levels; the a.v.c. voltage is used to increase the negative bias on the 6C5 grid in accordance with signal levels. At no signal the cathode bias alone is applied to the 6C5 grid, and its plate resistance is therefore only about 8000 ohms. Ten volts from the a.v.c. circuit increases this plate resistance to 30,000 ohms, with a rapid rise thereafter. Thus we have the automatic variable resistor for the automatic tone control.

This resistor is effectively in series with C_1, which is of such value that with minimum resistance in the 6C5 circuit a quite complete attenuation of the high frequencies will occur. On strong signals, on the other hand, the total effective resistance paralleling the pentode output load circuit will be so great as to have little effect.

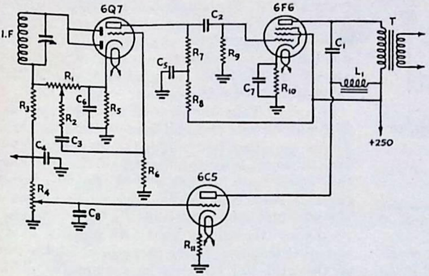


FIG. 13 — AUTOMATIC TONE CONTROL CIRCUIT PROVIDING BOTH BASS AND TREBLE ATTENUATION

The arrow, shown between R_3 and R_4, indicates a connection to the receiver a.v.c. line.

R_1 — 500,000-ohm volume control
R_2 — 50,000 ohms, ½ watt
R_3 — 2 megohms, ½ watt
R_4 — 2-megohm volume control
R_5 — 5000 ohms, ½ watt
R_6 — 1 megohm, ½ watt
R_7 — 250,000 ohms, ½ watt
R_8 — 10,000 ohms, ½ watt
R_9 — 500,000 ohms, ½ watt
R_{10} — 650 ohms, 2 watts
R_{11} — 250 ohms for 6C5; 1000 ohms for 56 or 76.
C_1 — 0.02-μfd., 400 volt rating (values between 0.01 and 0.05 μfd. should be tried)
C_2, C_3, C_4 — 0.05 μfd.
C_5 — 4 μfd. electrolytic, 400 volt
C_6, C_7 — 10-μfd. electrolytic, 400 volt
C_8 — 0.01 μfd.
L_1 — 42–185 henry swinging choke (Thordarson T-7430)
T — Pentode output transformer (tube load 7000 ohms)

So much for the treble control. The bass control is derived more or less as a by-product of the circuit just described. The 6C5 plate is fed through L_1. As far as audio frequencies are concerned this circuit is effectively in parallel with C_1 on weak signals, and in series, with a resistance shunt, on strong signals. On weak signals the operation is as follows: C_1 and L_1 in parallel add impedances in such relationship as to establish a decreased load resistance at both low and high frequencies (with the greatest decrease for high frequencies) in the pentode plate circuit. The medium frequencies are, however, scarcely attenuated. The pass band is thus effectively narrowed.

On strong signals two actions occur which render the entire circuit effectively inoperative. Increased resistance in the 6C5 plate circuit effectively places L_1 and C_1 *in series* across the load circuit, rather than in parallel. Normally, the effect of this would be to boost the ends of the frequency range and attenuate the middle frequencies. However, the increased grid voltage on the 6C5 lowers the plate current, which at no signal is 15 ma. At the same time the inductance of L_1 which at 15 ma. is only 42 henries, rises to maximum of 185 henries. Its impedance therefore becomes so great that its effect paralleling the load circuit resistance is negligible.

A surprising improvement in intelligibility and general noise level can be achieved through the proper operation of such a circuit as this, and the elimination of at least one manual control is a decided operating asset.

—···—

The Class C Audio Amplifier Applied to Regenerative Receivers

The amateur c.w. operator will readily recognize the added readability of a signal that "stands out" from the background noise present in nearly every short-wave receiver. We find some operators who like a slight modulation on the signal, others who like the piercing qualities of a pure d.c. note, but all will agree that the ultimate condition is that which would exist should there be no sound in the 'phones other than the desired signal.

The Class-C amplifier as described by W1EYM in the July, 1936, *QST* affords a simple but effective means of accomplishing a marked reduction or complete elimination of background noise. As the article describing this amplifier pertained largely to selectivity, the use of this amplifier as a means of reducing background noise in other than the superheterodyne type of receiver, may have been overlooked by many readers.

The accompanying diagram (Fig. 14) shows a Class-C amplifier somewhat similar to that described by W1EYM. Although an outgrowth of a background-noise reducer designed for use when copying short-wave press in commercial work, it nevertheless offers many possibilities for application to amateur work.

This amplifier may be used with any short-wave receiver having a reasonable amount of gain and properly constructed to have a fairly high signal to noise ratio — provided the receiver is equipped with a power output tube to insure plenty of "drive" for the Class C stage. The writer used the amplifier with a common four-tube t.r.f. receiver with extremely gratifying results.

The output stage of the receiver is coupled to the Class-C amplifier through the condenser C_1. The condenser-coil combination, C_2L_1 is not absolutely necessary, but was found to eliminate a low frequency "hash" present in the output when the bias was adjusted nearly to the point of plate current cut-off. In addition, it serves to "peak" the amplifier at about 500 cycles. The coil is the primary of an output transformer with about half the turns removed.

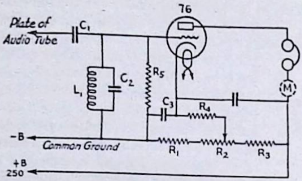


FIG. 14 — CLASS-C AMPLIFIER FOR NOISE REDUCTION

C_1 — 0.01 μfd.
C_2 — 0.00025 μfd.
C_3 — 0.01 μfd.
C_4 — 0.002 μfd.
R_1 — 7500 ohms
R_2 — 500,000 ohm variable
R_3 — 50,000 ohms
R_4 — 15,000 ohms
L_1 — Primary of output transformer with about half turns removed.

The resistor network across the "B" supply is used to obtain the necessary bias for Class-C operation. The center resistor, R_2, is variable, the arm being connected to the cathode through a 15,000-ohm resistor, R_4. In this way, the cathode can be made quite positive with respect to ground. Thus, the grid may be placed at a negative potential with respect to the cathode, variable from nearly Class-A to Class-C conditions.

In operation a signal is tuned in and the bias control adjusted to the point where all background noise drops out. The strength of the signal will decrease but slightly, although a change in tone will usually be noted.

It has been found that a certain minimum difference must exist between the strength of the desired signal and the strength of the background noise level to assure satisfactory operation. Thus, the usefulness of the device will be somewhat limited. The extent of this limitation will depend on the receiver, the location, frequency band used, and upon the amateur himself. Whereas the DX man, listening to weak or fading signals, might find the gadget of little value, the traffic man having schedules with several stations consistently S8 or S9 at his QRA might find his work made much easier and hence the amplifier quite valuable.

Incidentally, the milliammeter in the plate circuit may be used as a means of comparing signal strength. Although of little value on weak signals, it may be used to compare any signals sufficiently loud to permit satisfactory operation of the Class-C amplifier as a background noise reducer. — *Forrest A. Bartlett, W9FYK*

—····—

28-Mc. Band-Spread Coils

THOUGH these coils were designed for the National SW3 and 5, there is no reason why they will not work in any receiver employing six-prong coil forms.

Most owners of the SW5 have the black coils lying around. These coils are practically useless for ham work, since the 14-Mc. band occupies only three degrees on the tuning dial. A very good use is now found for them. With a few alterations, they can be converted into 28-Mc. band-spread coils. Here's how:

R.f. coil: Take one turn off the grid winding, drill a small hole and pull the loose end through. Leave the other two windings untouched. Now two turns up from the bottom of the grid coil, drill small holes on each side of the wire, being careful not to break the fine-wire winding. Scrape the wire and solder one lead of a fixed 100-μμfd. condenser (the midget kind with pigtails) to it; the other lead goes to the prong to which the top of the grid coil formerly was connected. This hooks the condenser in series with the tuning condenser as shown in Fig. 15. Now take a small Hammarlund trimmer condenser (EC-35) and bend down the large "ear." This is the "band-locating" condenser; it should then be connected across the ends of the grid coil. The top connection is made by drilling into the top side of the coil form and fastening the bent "ear" and the loose end of the coil, together with a flexible lead that goes to the control-grid cap on the r.f. tube.

The detector coil construction is the same with one exception — instead of the upper end the grid coil going to the band-locating condenser and the flexible lead as already described, a 100-μμfd. condenser, with a ½-watt 5-megohm resistor across it, is placed in series with the free end of the coil and the control grid lead, also shown in Fig. 15.

When these alterations are completed you have some efficient 28-Mc. band-spread coils. Set the 28-Mc. band at about 125 on the dial by adjusting the band-placing condenser on the detector coil in conjunction with a frequency meter; after this is done vary the condenser on the r.f. coil to bring the two circuits into resonance. The r.f. coil setting is not critical, but proper adjustment helps to bring the two coils in step. The spread is about 60 dial divisions.

Those who do not have National coils or the SW3 or 5 will find the following table of coil dimensions useful:

R.F. Coil Windings

Grid — 5 turns No. 20 enamel wire space-

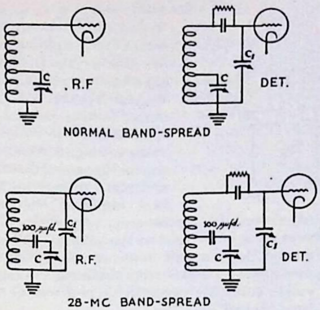


FIG. 15 — WIRING OF THE 28-MC. BAND SPREAD COILS

The normal band-spread arrangement used in the National SW3 and SW5 receivers is shown above. For 28 Mc., 100-$\mu\mu$fd. fixed condensers are connected in series with the tuning condensers (the tuning condensers have a maximum of 90 $\mu\mu$fd. in the National sets) and a mica trimmer is used on the r.f. as well as the detector coil.

wound 3/16-inch between turns, placed well up on the coil form.

Trimmer — 3¾ turns No. 32 wound in between grid winding.

Antenna — 3 turns No. 28 at bottom of coil form.

Detector Coil Windings

Grid — Same as r.f. grid coil.

Input — 2¾ turns No. 32 wound in between grid windings.

Tickler — 3 turns No. 28 at bottom of coil form.

In all other respects the construction is exactly as described above.

A word about the input winding of the detector coil. The National coil has 3¾ turns; I had to take off one turn so that the detector would oscillate in the old plate-feedback circuit, and found that it worked just as well as 3¾ turns in the screen-grid feedback circuit so I left it that way. Five-prong coil forms will suffice for the screen-grid feedback circuit.

The trimmer winding is a big help on these coils, for it peaks the signals as well as acting as a trap for loud local QRM.

— *Clyde C. Anderson, W6FFP*

—···—

A kink for 5- and 10-meter tuners: Twin phone-tip jacks, customarily sold riveted in a small piece of thin bakelite for "phono," connections, will mount very nicely across midget tuning condensers. Coils made of No. 14 wire will plug into them directly. Slight adjustment of inductance for tracking purposes in t.r.f. sets can be made by pushing the coils farther into the jacks.

— *W1NB*

A Cure for Receiver Hum

For some time a tunable hum has been present in my receiver in the vicinity of the 14-Mc. band. Neither a three-section filter consisting of 90 henrys and 48 μfd. nor an r.f. filter in the power supply leads had any effect.

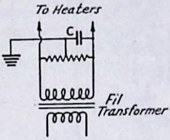


FIG. 16

The remedy was simply a small by-pass condenser connected across half the center-tapping resistor which is across the heaters, as shown in Fig. 16

With this condenser installed, every trace of tunable hum disappeared, and d.c. notes, which previously had been "fuzzy" in the 14-Mc. band, became just as clean-cut as in any other band.

The receiver is a three-tube affair, using one stage of tuned r.f. detector, and one audio. At present, the tubes used are two Type 36's and a 38, but the hum was just the same when two 24's and a 27 were used.

— *Curtis C. Springer, W9EMR*

—···—

An Audio Output Stage for the Regenerative S.S. Receiver

Several months ago I constructed the regenerative single-signal superheterodyne described in the *Handbook* but found that while the set functioned just as the data said it would, the total gain was not sufficient to bring in all signals with the sock I desired.

The obvious solution in such a case as this would be to substitute another tube for the 2A5 used as a second detector, and then use the 2A5 as a straight audio amplifier, but this would have necessitated drilling another socket hole and this in turn would have ruined the appearance of the chassis and also crowded things considerably. However, the problem was solved by using one-half of a 53 as the second detector and the other half as beat oscillator. Since the beat oscillator is coupled to the second detector, this was the logical combination of circuits. The whole audio and second-detector end of the receiver was then wired as shown in Fig. 17. It was found that the audio output was many times greater with this arrangement than when the 2A5 was used as a combination audio and second detector tube.

The circuit of the beat oscillator half of the 53 differs considerably from the former circuit using a 57. The connection that formerly went to the 57's cathode is grounded and the connection that was grounded is coupled through C_1 to the plate of the oscillator half of the 53. The grid connec-

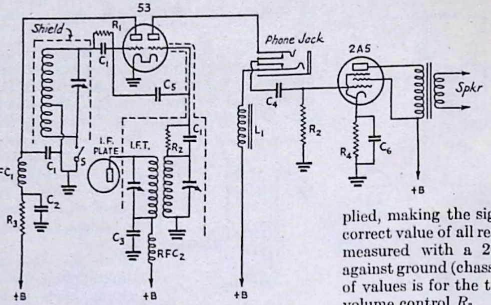


FIG. 17—THIS CIRCUIT MAY BE USED TO ADD AN AUDIO OUTPUT STAGE TO THE REGENERATIVE S.S. RECEIVER

It requires no additional sockets or major changes in the wiring. A 53 is substituted for the beat oscillator tube in the original circuit, combining the functions of second detector and beat oscillator in one bulb. The 2A5 then becomes a straight audio amplifier.

C_1—250-μμfd. mica condenser.
C_2—1-μfd. paper condenser.
C_3—.01-μfd. paper.
C_4—.01-μfd. mica.
C_5—Approximately 25 μμfd. (homemade).
C_6—10-μfd. low-voltage electrolytic.
R_1—50,000 ohms.
R_2—1 megohm.
R_3—2500 ohms, 5-watt.
R_4—400 ohms, 2-watt.
RFC_1—60 millihenry choke.
RFC_2—10 millihenry choke.
L_1—400-henry audio choke.

tion is the same except that the lead is brought out under the chassis. It was found that both parts of the tube worked very well with their common cathode grounded and there was therefore no necessity for inserting cathode bias.

There is really nothing unusual about the rest of the circuit, and the diagram is self-explanatory. The oscillator coupling condenser was made in this instance of about five inches of twisted wire with the dead ends insulated and the other two ends soldered to the two grids of the 53. This was found to give very good results since it did not overload the second detector but still produced a very good beat note.

I am convinced that this change will be welcomed by fellows having one of these receivers, as the gain in audio volume is well worth the trouble.

—*Lewis Van Arsdale, W9NQV*

—···—

Notes on Regenerative S.S. Receiver

A GREAT many constructors have written to me regarding construction of the S.S. receiver described in May 1934 *QST*, and in recent editions of the A.R.R.L. *Radio Amateur's Handbook.* While the *Handbook* specifications are correct, a typographical error in the original article gave an improper value for R_{16}, which should be 25,000 ohms, 5-watt, instead of 2,500 ohms. With the lower value too high screen voltage on the second detector and plate voltage on the beat oscillator were applied, making the signals seem very weak. With correct value of all resistors the following voltages measured with a 200-ohms-per-volt voltmeter against ground (chassis) were obtained. The range of values is for the two extreme positions of the volume control R_3.

Tube	*Plate*	*Screen Grid*	*Cathode*
R.F.	170–180	60–85	0–30
1 Det.	170–180	10	0–25
H.F. Osc.	170–180	75–85	0
I.F.	165–175	67–70	3
C.W. Osc.	75–85	7–10	0
2 Det.	150–170	75–85	0

W9NQV describes (in the preceding item) an effective means of adding a stage of audio amplification to the receiver, although this should not be necessary unless loud speaker reception of weak signals is desired on 20 and 10 meters where the gain is not as great as on the lower-frequency bands. A simple expedient which will increase the gain considerably on these bands is to use a 57 first detector in place of the 58, and to use the 40-meter coil on 20 meters and the 20-meter coil on 10 meters in the separately tuned r.f. stage.

Satisfactory coils for 10-meter reception can be wound on the small-sized National isolantite forms. L_4 and L_5 are each 3 turns spaced to one inch length of winding and L_5 is tapped one turn from the ground end, both coils of No. 18 enameled wire. L_3 is composed of 3 turns of No. 36 d.s.c. wire close-wound ⅙ inch from bottom of L_4. The holes in these forms make all these spacings readily attained.

—*R. W. Woodward, W1EAO*

—···—

W8DZU has a simple stunt for improving the "local" selectivity of tuned r.f. receivers. It is an ordinary wave-trap—made from a 140-μμfd. midget condenser and some spare plug-in coils—which is connected in the antenna lead and tunes over the band on which the receiver is set. The trap acts as a very effective r.f. input control, enabling distant stations within a few kilocycles of locals to be heard, and has negligible tuning effect on the receiver.

Building Pre-Selectors

W2AND has suggested that the SW-3 receiver makes an ideal basis for the construction of an excellent pre-selector.

Fig. 18 shows the original schematic of this unit, while Fig. 19 gives the circuit after conversion to the pre-selector. The numerals inserted at the points of various connections indicate the five major changes necessary for the conversion. Let's enumerate and explain them individually. Referring to the figures:

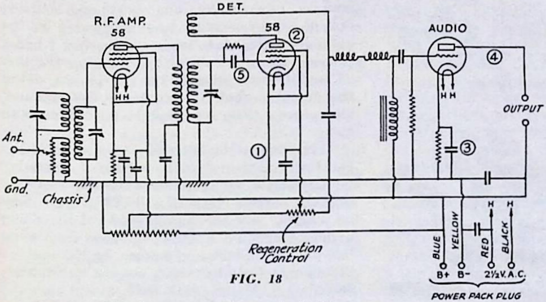


FIG. 18

1. Insert a 300-ohm resistor for cathode bias.
2. Open lead at plate of second tube, formerly the detector.
3. Remove condenser lead from cathode of audio tube and place in shunt with 300-ohm resistor, leaving ground connection intact.
4. Remove lead from plate of audio tube, and connect to the plate of second tube. This provides a direct connection from binding post to plate of second tube.
5. Remove grid leak and condenser of detector and make a direct connection to the grid of tube from the variable condenser.

The two-stage pre-selector unit is now ready for application to the particular receiver in use. It may be adapted to any short wave superheterodyne receiver in the ham station, regardless of whether or not it is already equipped with pre-selection. If the receiver is already equipped with a stage of pre-selection, it will certainly be a revelation to the operator when he once uses this unit in addition. The r.f. gain will be tremendous and the selectivity will be to the *n*th degree.

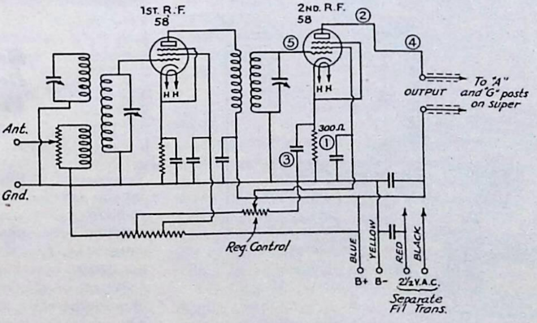


FIG. 19 — CARE MUST BE TAKEN TO SEE THAT THE INPUT CIRCUIT OF THE SUPERHET IS NOT GROUNDED

The application to a receiver not already equipped with pre-selection will put that receiver in the class of the finest short-wave super now available.

Either band-spread or regular coils can be used. The antenna trimmer dial is adjusted only once in the initial installation of the unit, to set the first and second r.f. circuits in resonance. The receiver's r.f. gain control is set on whatever point the operator finds comfortable to the ears, the "S-9" point (minimum gain) being used exclusively at this station. The gain can also be controlled by the operation of the former regeneration knob, which now governs only the gain of the second r.f. tube. This can be disconnected from the circuit if desired, as can any other component parts of the unit which are not being used. All has been left intact in this station since an emergency may arise requiring the original SW-3 for service. It would be very simple to reconvert back to the original circuit.

—...—

A Single-Tube Model

Fig. 20 shows a tuned-grid tuned-plate stage used by OA1B, designed and built especially for 14-Mc. 'phone reception by the late Mr. J. L. Stauft. The circuit and physical arrangement are shown in Fig. 20. This unit also was designed to be used with an FB-type receiver and employs SW-3 type coils with the primary windings removed. As indicated, the plate and grid circuits are coupled through a 3-plate variable condenser, which serves as the regeneration control in conjunction with the high-resistance variable cathode resistor. In operation, the feedback control condenser is adjusted so that the tube breaks into oscillation with a few hundred ohms of cathode resistance in circuit. Hence, this cathode resistor "handles" much like the regeneration control of a t.r.f. receiver. The point just below oscillation gives the maximum selectivity and gain. Under these conditions the signal strength is tremendously increased with a considerable reduction in background noise, the calibrated volume control of the FBX being kept down between "R6" and "R9" at all times—indicating no small improvement in useful sensitivity.

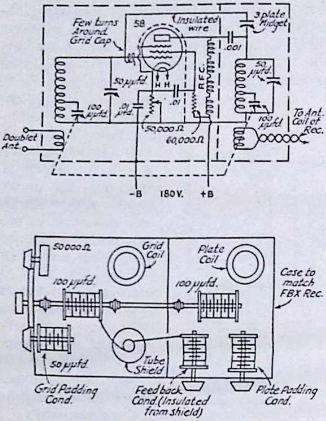


FIG. 20

Still another regenerative single-stage arrangement, used by W2AOE in his Single-Signal superhet, is shown in Fig. 21. Quoting from his short description:

"In the original design, some image trouble was encountered on 14 Mc. I finally decided to add regeneration to the r.f. stage to eliminate this difficulty and, at the same time, to increase the sensitivity. The problem was to do this job easily and quickly without adding more controls to the receiver. I did this by using the antenna coupling coil as a regenerative winding located in the cathode of the r.f. tube. In my receiver I had a cathode filament control operating on the first r.f. and detector stages. I cut the detector out of this circuit so that it is working at full gain and, at the same time, removed the a.g.c. from both tubes.

"Coupling to the antenna is now made with a two-turn coil wound on the outside of a Faraday (static) shield which fits over the coil socket so that the regular National coil (SW-3 type) may be plugged into the socket inside of the shield without difficulty. I made this shield from some 'air-wound' inductance similar to the sort of coil George Grammer made for his transmitter, described in March, 1934, *QST*, except that the material available was close-wound. No alteration was necessary in the former antenna coupling coils to secure regeneration on all bands.

"In operation, the receiver now works very smoothly, image response is completely eliminated, and a healthy increase in gain is obtained. With the r.f. gain control turned up and the i.f. gain control turned down, considerably less set noise results.

"Undoubtedly the boys who have built their own Single-Signal receivers would like to make the change. It certainly is a great improvement."

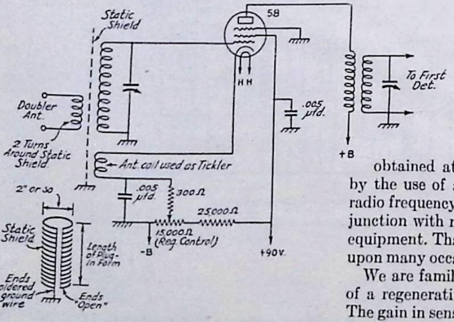


FIG. 21

—···—

Regenerative Amplification at Signal Frequency

Additional sensitivity and selectivity may be obtained at the cost of slight inconvenience by the use of a regenerative receiver having no radio frequency amplification, when used in conjunction with regular superheterodyne receiving equipment. That there is need of such sensitivity upon many occasions will be generally recognized.

We are familiar with the re-radiating qualities of a regenerative receiver of the type specified. The gain in sensitivity is obtained because of that quality.

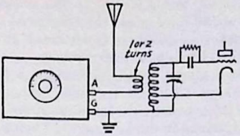


FIG. 22 — USING A REGENERATIVE DETECTOR AS A SIGNAL-FREQUENCY BOOSTER FOR AN AMATEUR-BAND SUPERHET

No constructional changes in either superhet or regenerative detector are required.

The procedure is as follows: Disconnect the antenna from your regular receiver and introduce the regenerative receiver between the antenna and the antenna post of the regular receiver. The antenna is connected to the antenna post of the regenerative receiver and the ground terminal of the regenerative receiver is connected to the antenna post of the regular receiver. Let the assumption be that an 80-meter signal had been tuned in prior to the introduction of the regenerative receiver. The next step will be to tune in that 80-meter signal on the regenerative receiver and it will be noticed that a very decided gain in signal strength is obtained.

Another method is to introduce an old regenerative b.c. tuner, such as the Radiola III, for instance, in the lead from an s.w. converter to the antenna post of a broadcast receiver used as an i.f. amplifier. The result is the same but the inconvenience is not so great, since the regenerative set need be tuned only once.

Other applications also may suggest themselves. — *Leonard C. Jensen, W1IW*

Editor's Note. — This scheme has excellent possibilities for increasing the amplification and providing signal-frequency selectivity with amateur-band superhets having no pre-selection. Its chief advantage is the fact that a discarded regenerative receiver (most ham stations have one) can be used without the necessity for even slight changes in the wiring of the superhet receiver.

Fig. 22 shows how the method has been used successfully with a receiver of the FB-7 type using the detector of the two-tube receiver described in June, 1934, *QST* as the regenerative signal booster. Although the ground post on the regenerative set can be connected to antenna on the super and the antenna run to the antenna post on the regenerative set, as suggested by W1IW, it has been found preferable to connect the ground posts of the two receivers together and couple the antenna lead to the regenerative tube through a turn or two around the detector coil as shown. This "ties down" the regenerative set and avoids body-capacity effects. The coupling to the regenerative tube is readily adjusted by varying the number of turns on the coupling coil. The coupling should be fairly tight, but not so tight as to prevent the regenerative tube from going into oscillation.

In operation both super and regenerator should be tuned just as they would if both were independent and were being used to pick up the same signal. With regeneration at minimum the regenerative tube will have practically no effect on the signal; with the regenerative circuit tuned to the signal frequency and adjusted just below the point of oscillation, however, there is a very marked increase in signal strength, depending upon the initial pick-up. If a short antenna is used, the increase may be as much as four or five R's, being particularly noticeable on 'phone signals. Careful observation indicates that the increase in signal strength is accompanied by an increase in the signal-noise ratio, the difference being perhaps one point on the S scale as judged aurally. That is, if the original signal was S4 and the background S2, adding regeneration might increase the signal to S8 and the background to S5. At any rate, it has been possible to bring up signals to readability from being just audible in the background without regeneration. Maximum gain is of course secured when the regenerator is worked just below the oscillating point; however, a definite gain results with the regeneration backed off far enough so that the tuning is not critical.

This method of introducing regeneration also provides a means for reducing image response in supers without pre-selection. Actually the image signal is left unaffected by the regeneration, but the increase in desired signal strength gives a decided improvement in the desired-signal to image ratio. Again talking in ham language, let us suppose that without regeneration the background is S3, the desired signal S5 and an interfering image S6. With regeneration at the critical point, the signal will be increased to perhaps S8, the background to S5, and the image will be unaffected. However, if the superhet gain control is reduced to bring the background back to S3, the desired signal will drop to S6 and the image to S4, approximately. In other words, the image is now considerably weaker than the desired signal instead of stronger as it was without regeneration, for the same background noise level in both cases. The figures are of course only approximate. In practice it has been possible to pull up an amateur signal from being unreadable below an interfering image to the point where it was perfectly readable with the image practically inaudible. This was done using a small antenna; the improvement may not be quite so marked with a larger receiving antenna.

The "catch" is of course that for maximum results the tuning of the regenerative circuit is just as critical as though the tube were being used as a detector. However, for general listening the regeneration can be backed off so that the superhet operates normally; when additional gain or selectivity is needed the regenerator can be brought into play. Since no constructional work is required it may be well worth a trial by those having ham supers without pre-selection.

—...—

A Simple Audiometer

A PRACTICAL audiometer of simplified design may be of interest to amateurs who want to give as correctly as possible reports of relative signal strengths. In judging radio signals the memory cannot retain for comparison the exact strength of the preceding day, and the ear itself is often insensitive to volume changes as great as two-to-one or even more. It is surprising how great a change must be made to appeal to the ear as a change of volume. A person trained in relative evaluation can differentiate between five values; very strong, strong, medium, weak and very weak. But the majority of us do well to distinguish between strong and weak.

A glance at the diagram, Fig. 23, will show its simplicity. In its commercial form the audiometer has a compensating series resistance which keeps the input impedance constant as the 'phones are shunted down the scale. In the simplified construction, however, this refinement is unnecessary because the impedance of the entire shunt resistance is purposely kept low relative to the impedance of the 'phones. The audiometer has five steps. Continuously variable adjustable resistors will not do because they vary too much. A small inductance switch with dependable fixed resistors should be preferred. The 0.1-ohm resistor is made up from a 1-foot 6-inch length of No. 28 wire wound on a small wooden dowel. The optional resistance, R_2, may be used with higher volume.

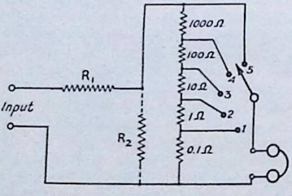


FIG. 23—A SIMPLE AUDIOMETER FOR MEASUREMENT OF RELATIVE SIGNAL STRENGTH

R_1 is used to match the required output tube load; 5000 ohms will be satisfactory in most cases. R_2 is a shunting resistor to be used only when the volume is too great without it; 10 to 500 ohms should be satisfactory.

It will be noted that each step increases the resistance across the 'phones (and therefore the voltage), by the approximate factor of 10:1. The power ratio, then, is 100:1; the common logarithm of 100 (and hence the number of bels) is 2; the number of decibels is 10 times this or 20. Therefore the steps are 20 db each.

On two stages of audio it rates a fair loudspeaker signal 5 and a very weak 'phone signal 1. In operation a signal is tuned in with the switch on tap 1, where it will be loudest. Then the switch is moved up the scale, putting the 'phones across smaller and smaller resistances until the signal can barely be heard. If the signal is heard weakly on 3 and goes out on 4, we rate the signal 3 on the 1–5 scale. Of course the figures mean nothing in themselves; they simply indicate the relative strength. It should be pointed out that using the same system any number of steps may be used to show any number of relative strengths.

—...—

Increasing C.W. Selectivity

IN TINKERING around I have run across a little scheme that seems to me to have possibilities as an inexpensive way of increasing the selectivity of c.w. receivers.

The stunt is to take the audio output of an autodyne detector, put the beat note through a low-pass filter, then build up the pitch with one or more frequency doublers to a tone desirable to copy. If the low-pass filter cuts off at 200 cycles, we can then separate stations 200 cycles apart and two doublers will bring the maximum tone pitch up to 800 cycles. Fig. 24 shows a simple layout tried at W3CIJ.

The low-pass filter was the common tone control carried to the extreme. A push-push doubler was used to cancel out the fundamental tone. Cathode resistor bias was used to get linear amplification. It might seem that the low-pass filter is unnecessary, but if it is not used there will be a beat between each two actual signals.

Results obtained here were about what would be expected. The audio transformer (or transformers as another stage was ahead of the doubler) seemed to cut off at about 100 cycles. With the tone control cut down low there was a nice peak in this region. The 100-cycle tone, of course,

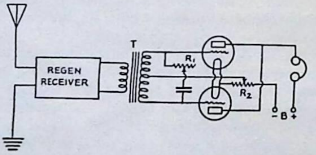


FIG. 24—AN AUDIO FREQUENCY-MULTIPLYING AMPLIFIER FOR USE WITH A LOW-PASS FILTER TO INCREASE SELECTIVITY IN C.W. RECEPTION

doubled to 200 cycles with plenty of higher harmonics to make the pitch sound higher. The receiver when tuned sounded something like a single receiver with two crystals either side of zero beat, except that the tone of a pure c.w. signal was changed to something that sounded like the old rotary sparks and was pleasing to copy. This must have been due to the harmonics generated in the doubler. By jiggling the bias resistor and plate voltage on the doubler many changes in tone could be brought about.

—*John P. Shanklin, W3CIJ*

—···—

Power Amplifiers for Regenerative Receivers

Many amateurs have trouble from howling when they attempt to put a power amplifier on their two- or three-tube regenerative receivers. With the idea of discovering the cause of this trouble, the two-tube a.c. receiver using a 58 detector and 56 audio described in the A.R.R.L. *Handbook* and *QST* for June 1934 was set up and a 2A5 pentode audio power stage resistance-coupled to the 56. No decoupling circuits were used and a 10-μfd. cathode resistance condenser was the only by-passing employed. The resistance used in the plate circuit of the 56 was the usual value of 50,000 ohms.

When the receiver was turned on, a low-frequency audio oscillation started immediately. The oscillation would cease only when the audio volume control was turned below about one-quarter way towards the full volume position. A decoupling network was then tried in the grid circuit of the 2A5. R_3, a resistance of 250,000 ohms, was inserted and the cathode by-pass condenser connected across both R_3 and R_4. After this change, the volume control could be advanced to mid-position without motor-boating. A decoupling network in the plate circuit of the 56 had no effect. A large plate by-pass condenser was next tried and when this capacity was increased to 16 μfds., it was possible to advance the volume control to almost maximum position.

At this point the value of R_1, the 56 plate circuit resistance, was reduced to 20,000 ohms. Although no reduction in gain could be noticed with the lower value of load resistance, the audio amplifiers were entirely stable at full volume. Later investigation showed that the plate by-pass capacity could be reduced to 8 μfds. with the lower value of plate circuit resistance.

Transformer coupling between the 56 and 2A5 was next tried. Tests with three or four different transformers showed that this type of coupling not only provided an appreciable improvement in gain over resistance coupling, which might be expected, but that the audio system was much more stable. With one or two of the transformers used no special measures were necessary to prevent oscillation; with others the decoupling resistor in the grid return circuit was necessary to permit full advance of the gain control. The decoupling resistor also served to eliminate a slight power supply hum which was first experienced.

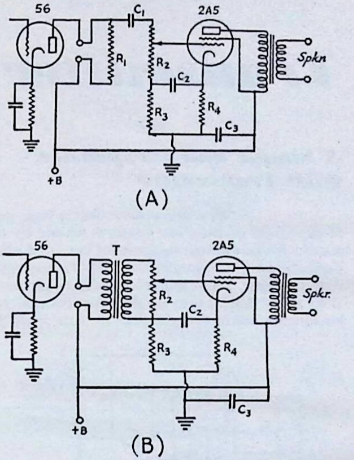


FIG. 25—SUGGESTED CIRCUITS FOR A SINGLE STAGE POWER AMPLIFIER

R_1—20,000 ohms, 1 watt.
R_2—500,000-ohm potentiometer.
R_3—250,000, ½ watt.
R_4—400 ohms, 1 watt.
C_1—.02 μfds.
C_2—1 μfd., 50 volts.
C_3—8 μfds., 400 volts.
T—Interstage audio transformer.

Since any plate by-pass capacity added is effectively in parallel with the power pack filter condenser, the value needed to obtain complete stability may vary somewhat with the values of filtering capacity used in the power pack.

The final circuits are shown in Fig. 25.

—*W1TS*

3

Transmitter Suggestions

A Simple and Inexpensive QRP Transmitter

We all realize that a large part of the QRM on amateur bands is caused by the use of high-power transmitters for local and other short-distance communication. The average amateur, however, is not financially able to put more than a few dollars into an auxiliary transmitter; he always needs every dollar he can spare for improvements on his main rig. There is one way, however, in which a very inexpensive low-power set suitable for short-distance communication can be built in a few minutes' time. It requires no additional power supply; only the key, crystal and antenna from the main transmitter.

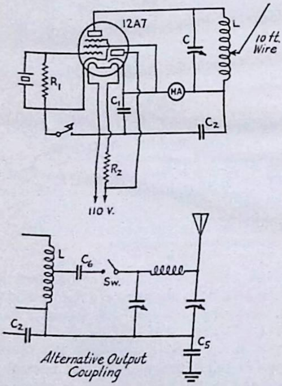


FIG. 1 — SIMPLE AND COMPLETE ONE-TUBE TRANSMITTER FOR LOCAL OR PORTABLE WORK

R_1 — 25,000 ohms.
R_2 — 350 ohms, 50-watt (line cord).
C_1 — 24-μfd. electrolytic, 200-volt or higher rating.
C_2 — 0.002 μfd.
C_3, C_4 — 500-μμfd. variable.
C_5, C_6 — 0.002 μfd.

Plate tank circuit, LC, has usual constants for frequency of crystal employed. The inductance in the pi-section coupler shown as an alternative output circuit likewise should be adjusted for the frequency and type of antenna used. This coil may be provided with taps.

I have built two such transmitters, using the circuits in Fig. 1, and have had very pleasing results with them. Using the simpler antenna system, I contacted a station 407 miles away and received an RST349X report; this was done merely by answering his CQ, not by the usual "low-power" method of contacting a station on high power and then shifting the crystal to a flea-power transmitter.

— *Carl C. Drumeller, W9EHC*

For the benefit of those not familiar with the 12A7, the tube consists of a pentode and power rectifier, with separate cathodes, in one bulb. W9EHC's circuit uses the rectifier to convert the 110 a.c. to half-wave d.c., the filter being condenser C_1. The r.f. part of the circuit is the familiar pentode crystal oscillator. A line cord with built-in 350-ohm resistor drops the 110 volts to the proper value for the heater of the 12A7.

— Editor.

—…—

110-Volt Transmitter Using 48's

One tube which offers possibilities for the low-power transmitter which must operate from a 110-volt d.c. line is the Type 48, a power amplifier tetrode the construction of which is such that it has pentode characteristics. This tube is capable of an output of about 2.5 watts as an audio amplifier, and should give more when operated at the higher efficiency characteristic of r.f. circuits.

A crystal circuit which has been used successfully by Dr. A. L. Russell, W9VOD, is shown in Fig. 2. It is adapted from the transmitter circuit given in *How to Become a Radio Amateur*, with such changes as are necessary to use the 48 tube. Using two tubes, a number of stations were worked on the 7-mc. band with an input of only 11 watts, one of them being 1100 miles distant. The screen voltage was dropped slightly by means of the 15-ohm resistor.

In an attempt to increase power, four 48's were used in push-pull parallel, the circuit diagram being the same as given except that two tubes were used on each side, the elements being connected in parallel. This permits connecting the heaters of all four tubes in series directly across the 110-volt line, and the resistor R_1 can be omitted. With four tubes the value of the grid leak, R_3, should be reduced to 15,000 ohms. Other constants remain the same. The power increase was found to be worthwhile, since a higher percentage of calls were answered and the transmitter got out better. It should be possible to run the input to 25 watts without much difficulty — a power which is not far from the average of many transmitters using 350- or 400-volt power supplies

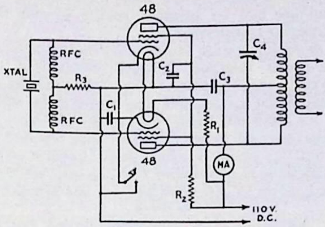


FIG. 2 — A 110-VOLT D.C. TRANSMITTER USING TYPE 48 TUBES

C_1, C_2 — .003 μfd.
C_3 — .005-μfd.
C_4 — 100-μμfd. variable.
R_1 — 200-ohm variable resistor to carry at least 0.4 amp.
R_2 — 15 ohms.
R_3 — 25,000 ohms.
RFC — Short-wave chokes (2.5 mh.)

As suggested in the text, four tubes may be used in push-pull parallel, in which case R_3 should be 15,000 ohms and R_1 may be omitted, the four heaters being connected in series across the line. The plate coil should have the requisite inductance to resonate at the crystal frequency in conjunction with C_4

W9VOD reports a curious thing in connection with using Type 48 tubes; apparently the tubes require "seasoning" during a few days' operation. At first very loose coupling to the antenna must be used; after the set has been in use for a while the coupling can be increased and more power taken from it. After the "wearing in" process is over, however, the transmitter has been found to be perfectly stable.

— · · · —

Battery-Operated Portable Transmitter

Fig. 3 is the circuit diagram of crystal-controlled portable transmitter used by Green Giebner, W4CPX, consisting of a crystal-controlled oscillator of the Tri-tet type modelled after the single-tube transmitter described in *QST* for March 1934. The circuit constants are similar to those specified in the article mentioned except that the screen voltage is obtained from a 50,000-ohm dropping resistor instead of from a voltage divider. The constants are given under the figure except for the coil data, which will depend upon the crystal frequency. The tube may be either a 41 or 42. For portable work a single-wire fed Hertz antenna cut to the frequency of the crystal is used, the feeder being tapped on the plate coil approximately at its center.

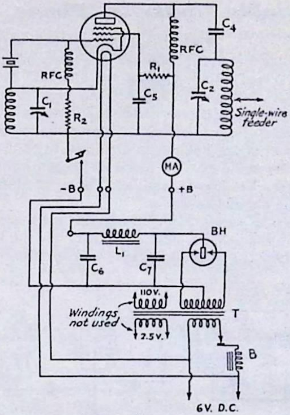


FIG. 3 — CRYSTAL-CONTROLLED PORTABLE TRANSMITTER AND POWER SUPPLY

C_1, C_2 — 100-μμfd. variable.
C_4 — .005 μfd.
C_5 — .002 μfd.
C_6 — 8-μfd. electrolytic.
C_7 — 4-μfd. electrolytic.
L_1 — 30-henry, 50-ma. choke.
T — Midget power transformer.
B — Low-resistance buzzer or vibrator.

Plate supply for the oscillator may be obtained from an automobile radio "B" eliminator or from an arrangement of the sort diagrammed. This consists of a power transformer of the midget variety, furnishing a few hundred volts each side of the center-tap on the high-voltage winding, working into a Raytheon BH-type gaseous rectifier and a brute-force filter. Direct current from the 6-volt storage battery is fed into the 5-volt rectifier winding on the transformer through a low-resistance buzzer or vibrator. With the particular transformer used by W4CPX the current consumption from the battery was approximately 4 amperes and the output voltage about 275 volts d.c. under the transmitter load. The transformer was rated at 350 volts each side of the center tap.

Tuning instructions may be found in the article referred to above.

Portable 75-Meter 'Phone

The circuit diagram of a portable 75-meter 'phone transmitter which has been used with considerable success by Ben C. Brown, W6BZF, is shown in Fig. 4. Four two-volt tubes are used; the r.f. part of the set consists of a 30 crystal oscillator driving a 19 amplifier with the two sets of tube elements arranged in push-pull, and the audio portion has a 30 speech amplifier driving a 19 Class-B amplifier. The input to the r.f. tube is about five watts.

W6BZF's rig is built into an ordinary monitor box, which shows that the outfit can be quite compact. It can be operated either from batteries or from a "B" eliminator having an output of 180 volts or less. Tuning adjustments would be the same as with any other oscillator-amplifier and Class-B audio outfits. The neutralizing condensers, C_3, are trimmers of the type used for padding receiving circuits, and should have fairly low capacity (the Hammarlund type EC-35, for example). Midget condensers are used to tune the oscillator and amplifier plate circuits, a standard-size receiving condenser being used for the antenna circuit because of the greater capacity needed. With five watts input the amplifier should be adjusted to draw 28 milliamperes at a plate voltage of 180, representing a modulator load impedance of about 6400 ohms. The Class-B output transformer should be one designed for a load of this order, although the exact value is not critical since the plate input to the r.f. amplifier can be adjusted readily to suit the particular transformer used.

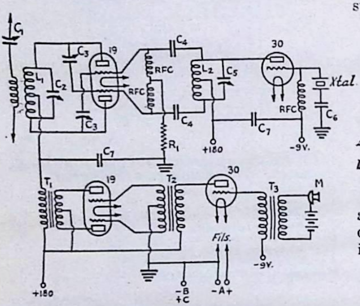


FIG. 4—BATTERY-OPERATED PORTABLE 75-METER 'PHONE

L_1—32 turns No. 20 s.c.c. wire on receiving coil form; antenna coils 5 turns each.
L_2—28 turns same. L_1 and L_2 both tapped at center.
C_1—500-μμfd. variable.
C_2—100-μμfd. midget variable.
C_3—Neutralizing condensers; low-capacity trimmer or padding condensers.
C_4—100-μμfd. fixed mica condensers.
C_5—100-μμfd. midget variable.
C_6—150-μμfd. fixed. C_7—.001-μfd. fixed.
R_1—20,000 ohms.
T_1—Class-B output transformer to couple Type 19 tube to load of approximately 6000 ohms (such as Collins 740 Z).
T_2—Class-B input transformer to couple a Type 30 driver to Type 19 Class-B amplifier (such as Collins 750 X).
T_3—Single-button microphone transformer.
M—Single-button microphone.
RFC—Short-wave type chokes.

As an interesting commentary on the high-*vs.*-low-power question, W6BZF writes that on several occasions he has asked other stations to stand by for the portable after having raised them on his 500-watt 'phone, the average difference in signal strength between the two being reported as about two points on the S scale. Reports of S7 to S9 have been obtained with the little set from stations up to 250 miles away in late afternoon.

—…—

Vibration in a copper-tubing coil can be squelched by stuffing a rubber bath sponge inside it. The sponge should make a snug fit, of course. *—W7CTN*

—…—

A "Fly-Power" 'Phone Transmitter Using a 6A7

Two circuits suggested by Leonard Tulauskas, W9LKV, for using a 6A7 tube as a crystal oscillator with modulation applied to the inner grid, are shown in Fig. 5. The upper circuit

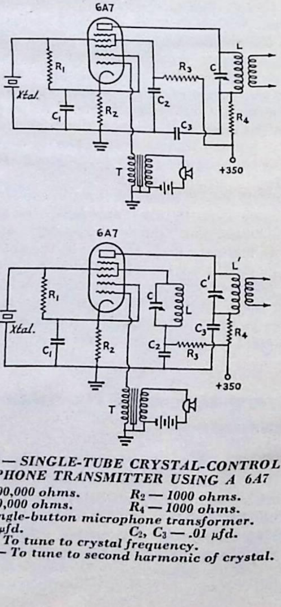


FIG. 5—SINGLE-TUBE CRYSTAL-CONTROLLED 'PHONE TRANSMITTER USING A 6A7

R_1—500,000 ohms. R_2—1000 ohms.
R_3—40,000 ohms. R_4—1000 ohms.
T—Single-button microphone transformer.
C_1—1 μfd. C_2, C_3—.01 μfd.
C, L—To tune to crystal frequency.
C', L'—To tune to second harmonic of crystal.

is for operation at the crystal frequency, while the lower is for obtaining output at the second harmonic of the crystal. In the latter case a circuit tuned to the crystal fundamental is inserted in the screen (grids Nos. 3 and 5) lead, the plate circuit being tuned to twice the crystal frequency. The ordinary single-button mike and transformer will have high enough voltage output to modulate completely the output of the oscillator.

W9LKV writes that no frequency modulation is detectable as long as the plate current of the oscillator does not change with modulation. These circuits have been used very successfully for short-distance work on the 160-meter band, using an input of less than three watts to the tube. They should be of interest to the amateur who wants an inexpensive low-power rig for local work or for portable use.

—···—

More on the 6A7 Transmitter

In view of the fact that I have received numerous letters from amateurs who have tried the transmitter using a 6A7 tube asking for more information, I have the following additions to offer to the circuits as shown.

(1) To facilitate easy oscillation, a coupling condenser of 15–25 μμfd. should be added between No. 4 grid and plate.

(2) If the output from the secondary of the microphone transformer is less than 10 volts, an additional stage of speech amplification may be used to give 100% modulation.

Several local amateurs brought their transmitters to me when they failed to make them work properly and in all cases were satisfied with the results obtained after the above changes were made. In one case the tube is used as a driver for a Class-B 59 tube. This seems to be a particularly useful application as a very stable transmitter is obtained with enough output for moderate DX.

— *L. Tulauskas, W9LKV*

—···—

Notes on 14-Mc. C.C. Transmitters

From QSO's on the 3.9-mc. 'phone band I find that many hams are having trouble in making crystal controlled rigs work on 14 mc. This was the case at W8HCR, and about three months were wasted in trying to obtain sufficient excitation to a pair of 10's in push-pull on 14 mc. The following points seem to cover the main sources of trouble.

1. In using Type 46 or 47 tubes as doublers, high plate voltage seems to be necessary and desirable. The 47 is used the same as a 46, with the two grids tied together. A plate voltage of 500 to 600 volts is desirable and is safe if the grid bias is kept high on these tubes.

2. Do not use automatic grid bias of the grid leak type on these tubes at plate voltages above 400 volts. If a fixed grid bias of between 50 and 150 volts is used, depending on the plate voltage and the output needed, there is no danger of the grids going positive under any normal load. This fixed bias may be obtained from batteries or from a "C" bias eliminator with a low resistance voltage divider (not over 20,000 ohms for a 250-volt supply).

3. Neutralizing seems to make no appreciable difference in the operation of the frequency doublers.[1] When using the 46's neutralizing is easy and the tubes may then be run as straight buffers at any time. However, 47's are difficult to neutralize and are usually run as doublers only.

4. Capacity coupling between stages is used, the condenser being connected directly to the plate end of the preceding tank coil. Capacity values can be from 40 μμfd. to 100 μμfd. for coupling between the oscillator and the doubler stages. The capacity for coupling from the second doubler to the 210's in the Class-C amplifier may range from 100 μμfd. to 500 μμfd.

5. No series radio-frequency chokes were found necessary in the plate supply leads. These leads were each by-passed to the filament center-tap with a 0.002-μfd. condenser.

6. Shielding between stages was found to be absolutely necessary and was the point that had been causing practically all the trouble. Without shielding, the tuning of the second doubler and final amplifier was extremely critical, and regeneration was being set up in such a way as to counteract a large part of the excitation voltage which was being impressed on the Class-C stage. As a consequence the final amplifier would not load up and the doublers ran extremely hot. The shielding as used consisted of galvanized sheet iron baffles between stages with a height great enough to extend above all apparatus in each stage. Also, a galvanized iron sheet was placed on the sub-base and all parts mounted on top of this. No shielding was needed in front or back of the stages and none on top. The shielding was insulated from all equipment and connected at one spot to the negative "B" lead. This cleared up all the trouble and each stage tuned up as easily on 14 mc. as on 3.9 mc., and sufficient excitation was obtained to drive the final 210's in the modulated stage.

In conclusion I wish to state that the information on shielding and plate voltages was given me by W8DLD and came at a time when it had seemed to be impossible to make the transmitter work properly. I am passing this information along to the rest of the hams in hopes that it may help someone else who has been having the same troubles. — *Weldon B. Sanger, W8HCR*

---

[1] Neutralizing accomplished by feeding r.f. voltage from the plate circuit back to the grid often increases the efficiency of a doubler stage by introducing some beneficial regeneration, although there is no tendency toward oscillation. This effect seems to be more pronounced with low- or medium-μ tubes, however, than with high-μ tubes which inherently are good doublers. — Ed.

* * *

If that two-year-old 7-Mc. crystal hasn't the sock it once had, borrow a reading glass and examine the edges for nicks. The output of some 7-Mc. plates is considerably reduced by nicks too small to be observed without magnification unless you have unusually sharp eyes. This effect is noticeable to a lesser extent on 3.5-Mc. plates if X cut; rough edges have no apparent effect on the operation of Y-cut plates. However, the majority of 7-Mc. crystals are X cut and the 7-Mc. plates are the ones affected the most. Refinishing the edges is a simple job and oftentimes will double the output. — *W6BCX*

* * *

TNT "R" Circuit

A VARIATION on the "R" circuit which should be of interest to fellows using locked oscillators, suggested by Fred C. Allen, VE3SA, is shown in Fig. 6. The crystal is simply coupled through a small coil to the cold end of the grid coil of the ordinary TNT oscillator. No changes are required in the oscillator itself.

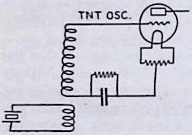


FIG. 6—TNT CIRCUIT WITH CRYSTAL LOCK

VE3SA uses a coupling coil of seven turns on a tube base closely coupled to the 60-turn grid coil on the same form (3.5 Mc.). The oscillator is a Type 50 with about forty watts input. The crystal load can be adjusted to a safe value by changing the coupling between the two coils, either through variation of the spacing or by changing the number of turns on the crystal coupling coil.

* * *

Caliper Coupling

MANY who are using link coupling between stages have found it a problem to vary the coupling when using the split-condenser circuit, with both ends of the coil "hot." A satisfactory solution has been found here by using a caliper-like coupling device supported by a standoff insulator at one side of the tank coil.

The coupling caliper consists of a single turn of copper tubing sawn into two semi-circles and flattened at the joint to take a screw. Lock washers and double nuts are used to prevent the adjustment tension from loosening after repeated movements of the two halves. To this center joint a brass right angle is attached, being fastened by the same screw which holds the two halves of the coupler. The assembly in turn is mounted on top of the standoff insulator, as shown in Fig. 7. With plenty of excitation it is rarely necessary to have more than one turn of coupling between the plate of one stage and grid input coil of the stage following. It is possible that on low-power stages more turns will be needed to effect adequate transfer and this is best made in the form of a coil wound at the cold end of the tank coil. The adjustment is not critical, but too close coupling should be watched because of the detuning effect.

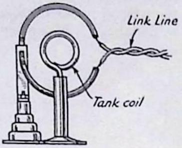


FIG. 7—A "CALIPER COUPLER" FOR GIVING VARIABLE COUPLING IN LINK CIRCUITS WITH BALANCED TANKS

In the construction of the caliper coupling device it is wise to bond the two halves with a heavy, well-soldered flexible wire to prevent the possibility of high-resistance connections at the friction joint. The transmission line is best made of solid wire in preference to the stranded kind, and is soldered to the two ends of the caliper. The other end can terminate in a similar coupling device. — *W. H. Hannah, W2US*

* * *

Variable Antenna Coupling

IN FIG. 8 is shown a scheme which I found very helpful in adjusting antenna coupling.

As you can see in the diagram, the adjustable

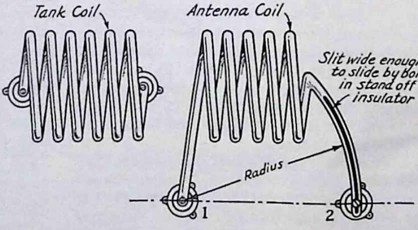


FIG. 8—METHOD OF LOCKING THE COPPER-TUBING ANTENNA COUPLING COIL IN PLACE

arm of the copper-tubing coil is bent so that it is the radius of an arc with standoff insulator No. 1 as the center. The slot may be made by boring holes along the tubing for about ¾ inch and then filing until that part of the slot is smooth on both sides. The remainder of the slot is sawed with a hacksaw, using two blades in the hacksaw to obtain the necessary width. A light filing is necessary to finish the job nicely. In use, the bolts in standoff insulators 1 and 2 are loosened slightly (No. 1 less than No. 2) and the coil is adjusted for desired coupling. Tightening the bolts gives a rigid "job" with desired coupling.

Needless to say, the adjustable arm is flattened before drilling and sawing operations are begun. Quarter-inch copper tubing is used here.

— *King Ramsey, Jr. W5EJS*

—···—

It is much cheaper to replace flashlight bulbs than meters or tubes. Put the bulbs in strategic locations in the circuit — in series with tube plates, meters, neutralizing condensers, etc. The 2.5-volt bulbs blow at about 300 mils and can be used in circuits with potentials as high as 80 volts. — *W2AOY*

—···—

Adapting Inductive Neutralization to the Low-Power Transmitter

Inductive neutralization of triode r.f. amplifiers has recently come into use in commerically-manufactured transmitters.[1] A trial of this method has convinced me that it can be easily and profitably adapted to apparatus of the home-grown variety.

Following are some details of its use in the final stage of a portable rig consisting of 59 Tritet, 59 neutralized buffer and two 46's as either push-pull straight amplifier or back-to-back doublers. The plate coils of the last two stages are both wound on the same 7-prong coil form. The diagram, Fig. 9, shows the connections for straight amplication and for doubling. Direct coupling between buffer tank and amplifier grids may be unorthodox, but it works and has the advantage of simplicity.

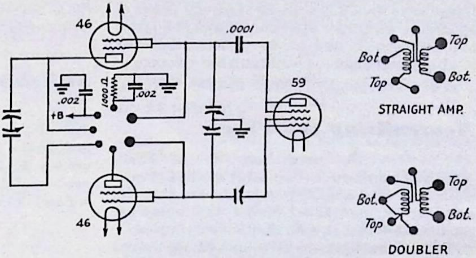


FIG. 9 — CIRCUIT FOR CHANGING FROM INDUCTIVELY-NEUTRALIZED STRAIGHT AMPLIFICATION TO BACK-TO-BACK DOUBLING BY PLUGGING IN APPROPRIATE COILS

The "top" and "bot." refer to the positions of the ends of the windings on the coil form.

Above are coil specifications for the three main bands, using 100–100 μμfd. split-stator tank condensers in both buffer and final stages.

All coils are wound on ribbed ceramic forms which plug into a small 7-prong socket. For straight amplification the two windings are wound in opposite directions and for doubling they are wound in the same direction. After the coils are wound some adjustment of the spacing between windings is usually necessary to obtain perfect neutralization, and when the correct position is found the windings should be fastened in place with coil dope.

Band	*Dia. of Form*	*Space Between Windings*	*Size of Wire*	*No. of Turns*	*Length of Winding*
14,000 . . . . Doubler	1¾″	5/16″	Bfr. Pl. 18 d.c.c. Amp. Pl. 18 d.c.c.	14 10	¾″ 1¼″
14,000 . . . . Str. Amp.	1¾″	11/16″	Bfr. Pl. 18 d.c.c. Amp. Pl. 18 d.c.c.	7 10	⅜″ 1¼″
7000 . . . . Str. Amp.	1¾″	⅞″	Bfr. Pl. 18 d.c.c. Amp. Pl. 18 d.c.c.	14 15	¾″ 13/16″
3500 . . . . Str. Amp.	2¼″	1⅛″	Bfr. Pl. 22 d.c.c. Amp. Pl. 18 d.c.c.	21 29	11/16″ 1⁹⁄₁₆″

Coupling to the antenna tuner may be by means of a small coil wound on celluloid and placed so that it slips inside the amplifier tank coil when the form is plugged into its socket. One or two turns wound directly over the amplifier tank coil when the form is plugged into its socket. One or two turns wound directly over the amplifier tank coil, terminating in flexible leads fitted with G.R. plugs, may also be used.

---

[1] See Craft and Collins, "Inductive Neutralization of R.F. Amplifiers," July, 1936 *QST*.

Estimated outputs, using an 80-meter crystal, range from about 20 watts when doubling to 20 meters in the final stage, up to nearly 50 watts on both the 40- and 80-meter bands. The use of this scheme results in a saving of several pieces of apparatus with their attendant losses and space requirements. It also allows optional doubling in a push-pull stage and facilitates band changing.

—*O. K. Blackburn, W9MB*

Neutralizing the Final

A note from E. A. Krall, W8CKO, points out a reasonable method of neutralizing a final amplifier to make sure that the amplifier is neutralized under the operating conditions — that is, with the antenna coupled — and that no back wave will be emitted. He writes:

"The procedure is quite similar to the regular way of neutralizing except that an indicating device such as a low-range r.f. ammeter or flashlight bulb is inserted in the antenna lead and the final is purposely pushed out of neutralization. Of course the plate voltage is disconnected. The neutralizing condenser is then turned until all indication of radiation disappears and further turning in the same direction causes it to start to rise again. The optimum point is naturally the *zero setting* between the two settings which show *antenna current*.

"Using the above method, no trouble is experienced in neutralizing a W.E. 212E on 20 meters. Out of neutralization the 852 buffer pushes over an amp into the antenna, and it's just like rolling off a log to neutralize this high-capacity tube on 20. Similar results were obtained using a 204A in the final. Anyone who has worked me on 40 or 20 will vouch for the fact that I have no back wave."

A Neutralizing Kink

A note from W6IY gives a useful hint on neutralizing buffer stages: "A wrinkle borrowed from Ole Friend Commercial Practice has to do with the neutralization of a stubborn buffer stage in a 47-10-203-A rig. Using an r.f. galvanometer as an indicator it was impossible to remove all traces of r.f. from the buffer tank. The final amplifier, with its split-stator tank, neutralized perfectly. The 10 stage was stable enough to allow its use as a driver to neutralize the final, which was done according to Hoyle. Then plate voltage was removed from the buffer and full plate voltage applied to the final. If the final is biased to cut-off or slightly beyond, any current flowing in its plate circuit is the result of excitation fed through from the unneutralized buffer stage. In my case, this current could be reduced to zero by adjusting the buffer neutralizing condenser, keeping all tank circuits in resonance throughout the operation, of course. A final check made on the buffer tank with the r.f. meter showed just a trace of residual r.f., the source of which is unknown (probably because coupling the r.f. indicator caused a slight unbalance — *Ed.*), but the whole set operates stably at all frequencies and in a perfectly normal manner."

Switching 53 Sections

A note from Vernon S. Parks, W9SZK, points out a simple way of getting around the necessity for neutralizing the second section of a 53 when working straight through in exciters using this type of tube as a crystal oscillator and doubler. The scheme is shown in Fig. 10.

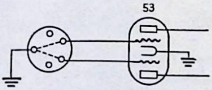


FIG. 10 — SHIFTING THE CRYSTAL FROM ONE 53 SECTION TO THE OTHER FOR EITHER STRAIGHT-THROUGH OR DOUBLING

Since most crystals plug into five-prong sockets, the socket wiring is very easily arranged so that simply by selecting the right pair of socket holes the crystal can be connected to the grid of either 53 section. When working the transmitting on the crystal frequency, the section which is normally the crystal oscillator tube is jumped entirely, the second section taking its place.

Wiping Out the Harmonic

Operating r.f. amplifiers at high efficiency means plenty of harmonic content in the output, usually. R.f. harmonics from the output stage do nobody good and can bring plenty of trouble down on unsuspecting heads. Many signals heard off-frequency are actually from transmitters whose intended output is on some lower-frequency band — which is really no valid excuse for off-frequency operation because it's up to the operator of the station to see that harmonics are suppressed. The following excerpt from a letter from B. P. Hansen, W9KNZ, outlines an inexpensive and satisfyingly simple method of wiping out the harmonic:

"One result of all this going over to crystal control is that the gang are using fairly efficient final amplifiers — high bias and excitation, low-*C* tanks and high plate voltage — with the result that harmonics have been raising the old merry heck. The stunt shown in Fig. 11 is simple and wipes 'em out.

"The idea is simply to feed the harmonic into a trap circuit and let it do the old merry-go-round there instead of going up the flue and blocking somebody's receiver on the harmonic frequency — or getting into some nice AGSX in one of Uncle Samuel's monitoring stations. It works every time, and while in some cases it won't *completely* eliminate the harmonic, it will reduce its strength so much that it no longer bothers anyone. So far as I've been able to determine, low-C is better than high-C in the trap, probably due to better Q or something. An extension insulating handle about a foot long should be put on the trap condenser shaft to get away from body capacity. Also, the trap should be pretty close to the transmitter to prevent radiation of the harmonic from the feeder. Tune in the harmonic on the monitor and, listening closely (with key down of course), tune the trap over the scale. As it passes through resonance, POOF! out goes the harmonic, and out it goes at the other fellow's receiver. That's all there is to it.

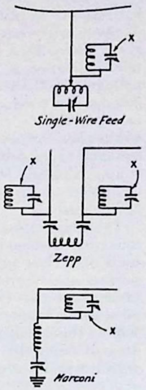


FIG. 11

"Yes, I've heard of traps in series with the feeders and all that, but they invariably introduce losses and most fellows won't stand for that even though it means giving others something of a break. But so far as I've been able to see, this stunt doesn't react on the final amplifier at all — and even if it does the loss is so slight as to be negligible. I've tried tests time after time, while working all bands, with both local and distant stations, and the reports are invariably the same — no change in strength of fundamental signal and complete obliteration of the harmonic. I had a 20-meter harmonic from my 40-meter rig strong enough to get S7 reports from the east coast, and could wipe it out 100% with this stunt."

While you're about it, it might be a good idea to pay some attention to the third as well as the second harmonic, especially if the output stage is a push-pull affair.

—...—

Quick Shift for Amplification or Doubling

Here's a stunt that worked out a problem for me, and it might be interesting to any of the boys who are using a pair of RK23's or similar screen grid tubes for either a back-to-back doubler or push-pull buffer on a chassis-type rig. What I wanted was a plug-in changeover from doubler to buffer, with link coupling complicating the situation. The solution was a 6-prong jumbo coil form. In either service, the grids are excited push pull, but the 40-meter (buffer) plate tank is so connected to the base prongs as to provide push-pull plate connection, with the link in the middle at low r.f. potential. The 20-meter plate tank is connected to *parallel* the plates of the tubes, and the two sections of the split-stator condenser. Also, the link is wound on the "ground" end of the coil form.

The diagram of Fig. 12 gives the general idea of the circuit arrangement and the connections of the coils. — *M. C. Bartlett, W9JHY*

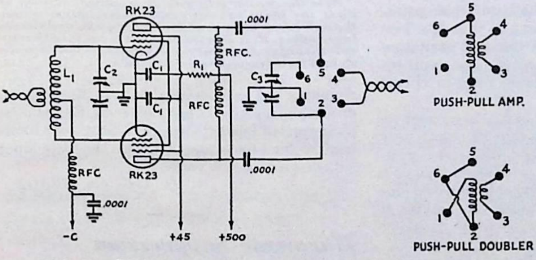


FIG. 12 — PLUG SWITCHING FOR STRAIGHT AMPLICATION AND DOUBLING

C_1 — 0.005 μfd.
C_2 — 50-μμfd. split-stator condenser.
C_3 — 50-μμfd. split-stator condenser, 1000-volt.
R_1 — 4200 ohms.
L_1 — Grid tank coil (plug-in if desired).
RFC — Sectional chokes (National type 100).

—...—

Regenerative Doubler

The cathode regeneration circuit for increasing the output of a 28-mc. doubler shown in Fig. 13 has been used with considerable success by J. P. Veatch, W9CJJ. Its resemblance to the electron-coupled oscillator, the harmonic-generating properties of which are well known, will be remarked. Although an 860, the particular tube to which the circuit is applied in W9CJJ's transmitter, is indicated, any transmitting tetrode or pentode can be used. With types having indirectly-heated cathodes the filament chokes will not be needed, thus simplifying the circuit. For filament-type tubes, the chokes may consist of about 15 turns of No. 14 wire on a two- or three-inch form, close wound, with one coil on top of the other. The inductance should not be particularly critical (see Romander, "The Inverted Ultraudion Amplifier," September 1933 *QST*). At lower frequencies more turns should be used. The cathode tap on the grid coil should be set so that the tube will not quite self-oscillate.

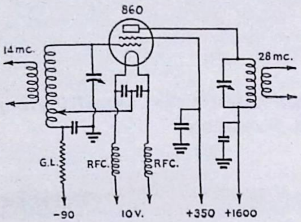


FIG. 13 — A REGENERATIVE DOUBLER CIRCUIT FOR USE WITH SCREEN-GRID TUBES

Used by W9CJJ with an 860 for 28-mc. output, this circuit is readily adaptable to other bands and other types of tubes, especially those having indirectly-heated cathodes.

W9CJJ uses the same circuit in the 28-mc. and 56-mc. doubler stages in a low-power crystal-controlled transmitter on five meters, and writes that he has obtained enough 2.5-meter output from an 89 in the same circuit to excite a 6D6 for suppressor modulation on 120 mc.

—···—

Automatic Protection with Grid-Leak Bias

PHONE men in particular will be interested in this bias scheme after reading Mr. Lent's excellent article on modulated Class-C amplifiers in *QST*, August, 1935. As stated by Mr. Lent, linear performance of the Class-C stage can only be secured when grid-leak bias is used and the grid is operated at the saturation point. Every amateur knows, however, that the bias voltage drops to zero when the grid excitation stops if a grid leak is used alone. The result often is a burned-out tube unless fuses or circuit breakers are employed.

The circuit shown in Fig. 14 has been used by the writer in a 1-kw. transmitter for over a year with excellent results. In operation pure grid-leak bias is used, and if the excitation fails or a buffer stage is keyed for telegraph, cathode bias is automatically cut into the circuit, making it impossible for the amplifier to draw excessive plate current.

The proper value for R_1, the grid leak, can be determined by Ohm's law. For example, if the bias voltage required for Class-C operation is 150 volts and the grid current required is 50 ma., E divided by I gives 3000 ohms. The value of R_2, which develops the cathode bias for tube protection when the amplifier is not delivering power, cannot be calculated quite as simply. Cathode bias is dependent on the amount of plate current flowing, so the plate power which the tube can dissipate safely must be used as a guiding factor. If we take a 203A as an example, the maximum safe dissipation is 100 watts. Then if the plate voltage is 1000, the maximum safe plate current is 100 ma. If we reduce the plate current to 50 ma. we then have a conservative dissipation of 50 watts when the tube is idling. Since the bias voltage required to reduce the plate current to 50 ma. is approximately 50 volts, as shown by the tube characteristic curves, by Ohm's law R_2 should be 1000 ohms.

The relay employed to short-circuit the cathode bias resistor should be adjusted so that the contacts will close on approximately 70% of the normal grid current. This adjustment can be made before the plate voltage is applied. Sufficient spring tension must be used so that the relay follows the keying perfectly. In operation, bias is secured from the voltage drop across R_1; the rectified grid current actuates the relay, short-circuiting the cathode-bias resistor, R_2. With no excitation no bias is secured from R_1, but the plate current flowing through R_2 provides a limiting bias for tube protection, with the plate input held down to a safe value.

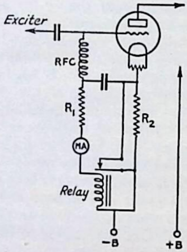


FIG. 14 — PROTECTIVE CIRCUIT FOR GRID-LEAK BIASED R.F. AMPLIFIERS

R_1 is the regular grid leak, R_2 a cathode resistor to limit the plate current under no-excitation conditions. When grid current flows through R_1 and the relay winding, R_2 is shorted out, but is cut into the circuit should grid current cease. The condenser between R_1 and R_2 is the ordinary r.f. bypass.

— D. A. Griffin, W2AOE

—···—

Harmonic Suppression

THE following note from M. W. Mitchell, W9IQZ, offers a cure for a condition that is likely to cause the unknowing operator some embarrassment:

"While QSO with W9JZJ recently, I was asked to listen on 38 meters for his 75-meter 'phone harmonic. We did and picked up the harmonic about S4 on loud speaker. JZJ was quite worried and was wondering what to do about it when I remembered a stunt that is used in broadcast stations quite often, told to me by W9PLF some time ago. We tried it on this QSO and it eliminated the 38-meter harmonic completely.

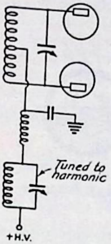


FIG. 15—WAVE TRAP IN PLATE SUPPLY LEAD TO ELIMINATE HARMONIC RADIATION

"The thing consists merely of inserting a wavetrap tuned to the undesired harmonic in series with the positive plate supply lead to the final amplifier. (See Fig. 15.) The wire of the coil must, of course, be heavy enough to carry the plate current of the amplifier. This system will work equally well with a self-excited oscillator coupled directly to the antenna as the wavetrap does not affect the tuning.

"For the 38-meter band, a coil of ten or twelve turns on a small form shunted by a 140-μμfd. midget variable condenser will do the trick very nicely. A neon lamp cannot usually be used as there isn't enough power on that harmonic to start it, but in a high-power rig one should be able to get it to light up. On low-power transmitters, a monitor tuned to the undesired frequency must be used, and the wavetrap tuned till the harmonic either disappears entirely or is much weaker, depending on the power of the transmitter.

"I might add that while testing with W9JZJ we both listened on 38 meters and it sounded very much like the 20-meter band. All kinds of ham signals were heard, with c.w. on the low-frequency end, 'phones on the high end, and commercials interspersed throughout!"

—*M. W. Mitchell, W9IQZ*

—. . . —

Milliammeter Switching for Grid and Plate Currents

Although many amateurs use plugs and jacks for transferring a meter from one circuit to another, it is often more convenient to use a switch for the purpose when the meter is to do only two jobs, such as reading grid and plate currents in a single stage. Bob Hayward, W9HDI, suggests the arrangement shown at Fig. 16A, making use of a single-pole double-throw switch to shift a milliammeter from grid to plate. With the switch thrown to the upper position the meter reads grid current; on the lower position a shunt is connected in to extend the meter range and the meter reads plate and grid currents combined. The shunt idea permits using a low-range meter of a value suitable for grid-current readings.

The circuit of Fig. 16B, used by Robert E. Foltz, W9GBT, makes possible separate readings of plate and grid currents, requiring, however, the use of a double-pole double-throw switch. With the switch thrown to the left, the milliammeter is connected to read plate current alone, a shunt also being connected in to extend the meter range. With the switch thrown to the right, grid current is measured. W9GBT uses a d.p.d.t. toggle switch for the purpose.

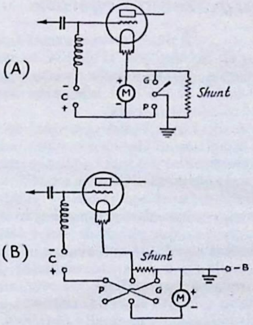


FIG. 16—SWITCHING THE MILLIAMMETER FROM PLATE TO GRID

In both diagrams the shunt may be omitted if the milliammeter range is sufficient to take care of the plate current taken by the tube or tubes.

—. . . —

Link-Coupled TNT Amplifiers

Nearly everyone who has tried link-coupling between stages, and between the transmitter output and the antenna tuning unit, is aware of its advantages over other methods of coupling.

The only real disadvantage, as I see it, is the necessity for adding tuning controls and the expense for extra variable condensers. Why not a TNT amplifier instead of t.p.t.g.? The TNT oscillators seemed to work as well as t.p.t.g. rigs so why wouldn't the same reasoning apply to a neutralized amplifier? If it worked the only disadvantage to link-coupling would be overcome.

I tried it on my rig and it sure did "perk." I got every bit as much excitation, the note seemed to *improve* and neutralization was more complete. What's more, there is no more apparatus used than with capacity coupling.

The TNT grid coil from an old self-controlled job was connected in place of the tuned condenser-coil combination and while it is doubtful if the coil was the proper size of the tube used, the rig performed perfectly. I have not as yet had time to experiment with different coil sizes but what little I have done has assured me that my new rig will be link-coupled throughout with TNT amplifiers in every stage.

— *Tom J. Boland, W6AJP*

—···—

Twenty-Meter Crystals

The following extract from a letter from R. N. McCord, W9MYX, is worthy of consideration by those contemplating using the new 20-meter crystals, or who may have been having trouble with them:

"Recently I purchased a crystal for fundamental operation in the 14-mc. band, using a 47 tube in the familiar pentode oscillator circuit. The circuit and constants used were exactly according to the bulletin furnished with the crystal. Several hours were consumed in attempting to make the crystal function, during which time I changed all of the circuit constants and even went to the extent of building a separate oscillator, but the crystal refused to oscillate. It was not until after a tank coil with spaced turns had been made up, that oscillation was finally obtained. A tank capacity of 50 $\mu\mu$fd., with a coil consisting of eight spaced turns of No. 14 wire on a 1½-inch form, were used. The rather heavy wire was found to be necessary because the crystal actually was a powerful oscillator, and the use of smaller wire caused the coil to heat considerably. The introduction of a winding form for the wire undoubtedly adds to the heating effect, and I would advise anyone building a similar oscillator to use self-supporting coils. With a plate voltage of 400 and screen voltage of 150 a power output of six watts was obtained."

—···—

Tube-Base Crystal Holders

The drawing of Fig. 17 gives the details of a tube-base crystal holder which, as its builder, Wilson Oliver, 53 Smith St., Detroit, Mich., says, "is simple to make and may be of use to somebody as a spare, if not as the one-and-only."

Continuing his description: "A standard-size four-prong tube base is used. Cut a piece of sheet copper or brass to fit inside the base as shown in Fig. 17. This forms the stationary plate. A wire is soldered to this and connected to both the grid and plate prongs. The part of the base between the brass plate and the shell is filled with melted sealing wax, in which is embedded a small bolt to hold the cover.

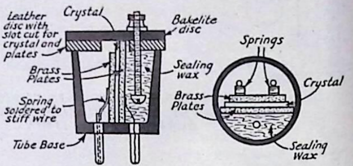


FIG. 17 — CRYSTAL HOLDER MADE FROM AN OLD TUBE BASE

"The top plate is made of another piece of brass or copper, held in place by brass springs soldered to small pieces of stiff wire projecting from both filament prongs. Both plates are ground flat.

"The cover is made from a disk of fibre or bakelite. The tube base I used was not quite one inch deep, so a piece of leather about ⅛-inch thick was cut as shown in drawing and glued to the back of the fibre disk. This keeps the cover from touching the crystal, which is one-inch square. A nut holds the cover in place.

"The holder is held in an ordinary tube socket, mounted vertically."

Another tube-base crystal holder, this one used by C. L. Tice, W7BEE, is shown in Fig. 18. It is intended to be used with a silvered crystal. W7BEE says this about it:

"This holder . . . should be FB for the ham who uses crystal control on a portable. No packing of the electrodes is necessary and shocks cannot do any damage unless they are hard enough to damage the tube base.

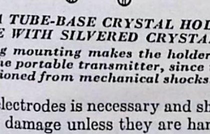


FIG. 18 — A TUBE-BASE CRYSTAL HOLDER FOR USE WITH SILVERED CRYSTALS

The spring mounting makes the holder especially useful for the portable transmitter, since the crystal will be cushioned from mechanical shocks.

"The holder is one of the old 01-A tube bases, which are longer than the present bases — long enough to hold a 1$\frac{1}{16}$" crystal. The springs are brass wire, about 24 gauge. A single turn to the coil will give flexibility so the plates will make firm contact all along the crystal, and the end soldered to the plate is turned at right angles so as to make more contact surface to hold the solder. The plate can be anything thin: copper, brass or monel metal, about 0.015″ thick. The cover is cemented on with Dupont Household Cement. Four springs are used, one in each prong, and the tension can be adjusted to a certain extent in the process of soldering the spring in the tube prong.”

—…—

Speeding Up Rough Grinding

The following kink, one which assists in cutting down quartz crystals with rapidity and economy, may be of interest to amateurs who do not have complete metallurgical equipment. In rough grinding, the usual home method is to grind on glass with a course abrasive. Since ordinary window glass is not satisfactory, the more expensive plate glass must be used, and after a little use must be discarded because of the concave surface left by grinding.

It is possible to make a rapid job of cutting down a thick crystal to the approximate finished thickness by grinding it on a sheet of Wetordry Trimite paper. A half or quarter sheet of grit 150-C taped down on all edges to a flat surface forms a rough but level base on which to grind. The actual grinding is done with water in the usual way, adding a little 280 mineral (silicon carbide) to the surface when cutting slows up. Thus the sandpaper replaces the plate glass for most of the work. The finishing touches should be done with 400 mineral on the plate glass to insure perfect flatness.

The sandpaper also serves as an excellent abrasive for rounding off corners or smoothing the edges.

— *T. J. Miller, ex-W9OYC*

—…—

“Locked” Amplifiers

A variant of the oscillating amplifier known as the Goyder “lock-system” has attained considerable popularity in Europe, according to a letter from J. Fleurbaey, ON4ZA. Described briefly, the amplifier is simply a TNT oscillator with its grid coil loosely coupled to a crystal oscillator or doubler tank; to get crystal control the oscillating amplifier is tuned to the same frequency as the crystal oscillator or doubler and because of the well-known tendency of two coupled oscillators to “lock” at the same frequency the crystal tube takes control. The result is a signal with all the characteristics of crystal control but obtained without neutralization and without worry of getting adequate excitation for the amplifier, since it supplies its own excitation. A simplified diagram is shown in Fig. 19.

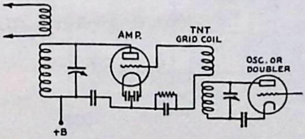


FIG. 19 — TNT OSCILLATING AMPLIFIER

Values may be those ordinarily used for TNT circuits. The crystal oscillator and doublers do not differ in any way from those which have been described previously in QST.

ON4ZA gives the following as the tuning routine:

1. With the power amplifier switched off, adjust the crystal oscillator (and doubler, if one is used) for maximum stability. Pick up the crystal signal in the monitor and adjust to zero beat.
2. With the crystal oscillator switched off, tune the TNT oscillator so that zero beat is obtained at exactly the same spot on the monitor dial.
3. Couple the grid coil of the TNT oscillator to the tank of the crystal-controlled driver and turn on the latter.
4. Retune, if necessary, until *only* a crystal-controlled signal is heard in the monitor, all tubes being “on.” When this condition is reached the two oscillators are “locked” and the crystal has control.

At ON4ZA the oscillating amplifier is a European-type 203-A with about 100 watts input. The oscillator tube is a 47, used with a crystal having a fundamental frequency in the 7-mc. band. The input to the oscillator is 7 or 8 watts, and the oscillator tank is coupled to the TNT grid coil for 7-mc. work. On 14 mc. a 46 doubler, running with about the same input as the crystal oscillator, is used, its output being coupled to the amplifier grid.

It should not be necessary to point out that a transmitter of this sort should be monitored *constantly*, and that it should be carefully checked every time it goes on the air after having been idle for a time. Frequency creep caused by tube heating often is enough to allow the tubes to get out of synchronism, which not only destroys the crystal-like character of the signal but may result in off-frequency operation.

—…—

Partial Application of Crystal-Lock System

Since the publication of my article on “Low Cost Crystal Control for High Power” in June 1934 *QST*, I have received numerous letters indicating an extensive interest in this type of crystal control. Since link coupling is fast becoming universal in its application another phase of the crystal-lock system is worthy of consideration.

In the present-day link coupling system, in which the grid circuit is tuned, it is seen that the final amplifier can readily be converted to a self-excited t.p.t.g. unit by de-neutralizing the amplifier merely by rotating the neutralizing condenser. If the final amplifier is of husky proportions and the doubler or pre-amplifier stage is of modest output power, a distressing condition may exist. This distressing condition is none other than insufficient excitation to the final amplifier. The transmitter can be converted to a partial lock-crystal system without any change at all except changes in adjustment. By partially de-neutralizing the final stage feeble regeneration will set up, which may not be enough to let the unit oscillate by its own excitation, but will be enough to furnish the added excitation required for increased output power. The coupling from the previous doubler or amplifier stage and stages farther back, including the crystal stage, can all be decreased, as little power is required of these units in crystal lock stages. Two 212-D's are used in push-pull at W5VU at present instead of the single 212-D that was in use when the article was sent to *QST* and the same 112 crystal oscillator and 46 doubler unit shown in *QST* is in use.

It will probably be found that the whole transmitter will function better as the tubes in the preliminary stages will have a chance to "cool off" and operate somewhere near their intended operating conditions. Incidentally, this should cut down the number of trips to the tube store.

—Durward J. Tucker, W5VU

—...—

Crystal-Locked Hartley Oscillator

In recent issues of *QST* I have noticed several references to the Goyder Lock system, or oscillating amplifier. All have asserted that the Hartley circuit would not work satisfactorily, and for that reason I made several attempts to get my old 852 Hartley rig to work that way before changing it into a neutralized amplifier. I hit upon one scheme which worked perfectly and actually gave 15% more antenna current for the same input of 180 watts than with the straight Hartley.

The method is to use link coupling to the tank of the exciting amplifier and direct coupling to the amplifier, as shown in Fig. 20. I used a three-turn pickup on the exciter end and tapped about one-third of a turn at the amplifier end on a 7-turn coil.

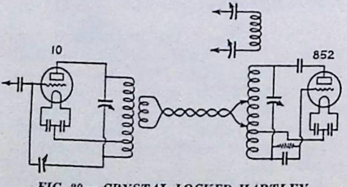


FIG. 20 — CRYSTAL-LOCKED HARTLEY OSCILLATOR

The low power stages are the same as used in the present arrangement. A 59 Tri-tet doubling to 7-mc., a 46 buffer, and a 10 with 820 volts on plate and 200 volts bias, running cold, as the exciter to the 852. With straight crystal control, the 852 as a neutralized amplifier now takes 260 watts at 1800 volts compared with the 180-watt maximum as an oscillating amplifier.

— Will A. Shaw, W5ARV

—...—

More Locked Oscillator Circuits

Fig. 21 shows several versions of a different type of locked oscillator circuit, originated by Carl C. Drumeller, W9EHC. A novel feature of these circuits is the use of a common tank circuit for the crystal oscillator and

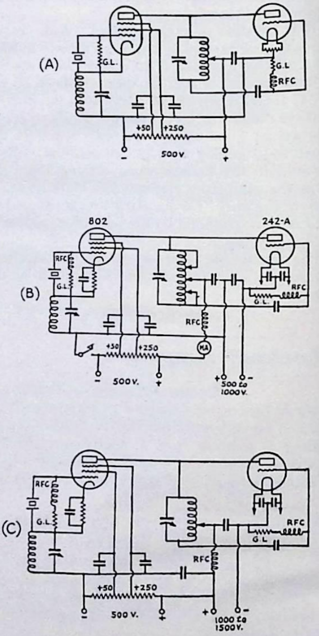


FIG. 21 — TRI-TET-CONTROLLED LOCKED OSCILLATOR CIRCUITS

Three variations of one fundamental arrangement. In each circuit the plate circuit of the Tri-tet oscillator and tank of the locked Hartley oscillator are common.

locked stage. The crystal oscillator is a Tri-tet, using a pentode of the 802 type; the amplifier or locked oscillator may be any type of triode, depending upon the plate voltage to be used. The tube used by W9EHC was a 242-A, with plate voltages up to 1750. Needless to say, a considerable amount of power can be taken from the tube under these conditions.

Although the circuits of Fig. 21 show the locked oscillator as a Hartley, all of the other familiar oscillator circuits have been tried and found to work satisfactorily. The Hartley has the advantage of requiring fewer parts than most, however, and the excitation is readily adjustable. W9EHC writes: "Results have been uniformly satisfactory. We put as high as 1750 or 2000 volts on the 242-A and it still locked perfectly under load on both the fundamental and second harmonic. When we tried to load the circuit on the fourth harmonic it did not lock any too well, however. The circuit shown at B seems to be the best. With over 200 watts into the 242-A, it locks as steady as a rock on both eighty and forty meters.

"Tuning is simple. One cuts the filament voltage on the 242-A and tunes up the 802 Tri-tet in the conventional manner, then one cuts the 802 filament voltage, turns on the 242-A, and juggles the filament tap on the Hartley for best output exactly as if you were using a self-excited rig. With filament and plate voltage on both tubes, the rig can be tuned by the plate current dips as with any Tri-tet.

"In circuit C we used a separate power supply for each tube (this was the best system, disregarding power supply cost and keying difficulties) and the whole rig could be tuned up, after the Hartley tap had been set, by the 802's plate meter. The rig acted exactly like a Tri-tet except that the output was very much greater.

"It is important to use very low *C* in the plate tank so that the Hartley will be unstable and pull into lock readily. The Hartley is always exactly in tune with the Tri-tet, since both plate circuits are common."

At this distance the only disadvantage to the circuit that we can see is that the full r.f. tank voltage from the high-power oscillator appears at the plate of the low-power crystal oscillator tube. No bad effects have resulted from this in W9EHC's experiments with the circuit, however.

—···—

Improving Crystal Stability

HERE are a few hints for eliminating frequency "creep" due to generation of heat by the crystal itself.

With the tuned-plate type oscillators, work with as low a plate voltage as practical on the oscillator tube. Triodes preferably should not have more than 150 volts on the plate, pentodes not over 250 volts. These plate voltages should be sufficient to excite any of the ordinary tubes used as buffers or doublers, such as the Types 10, 65, 47 and 46. If more output is required add another r.f. amplifier and let it take the load; not the crystal. Under any conditions never work the tube to the point where the crystal gives off a corona discharge or the electrodes "burn."

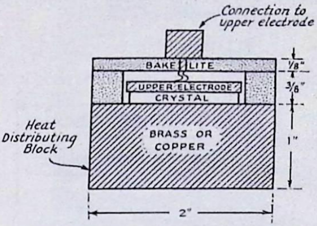


FIG. 22 — CONSTRUCTION OF THE CRYSTAL MOUNTING, WHICH MAY BE ROUND OR SQUARE

It is important that the electrode surfaces contacting the crystal be perfectly flat.

Do not tune the tank circuit for maximum output — work it considerably off-tune of the crystal frequency, on the high frequency side, of course.

With the Tri-tet type circuit the important adjustment to minimize creeping is in the tuned cathode circuit. As this circuit is tuned to lower its resonant frequency (tuning capacity increased) the excitation increases. With the circuit tuned near resonance creeping is likely to be bad, as the result of excessive r.f. excitation and heating of the crystal, and the output is likely to be less than that obtainable with the capacity considerably reduced. Therefore this circuit should be resonant to a frequency considerably higher than the crystal frequency, as has been pointed out in recent *QST* articles. With the Tri-tet the screen (or screen and suppressor) voltage should be adjusted for stability, about 100 volts being best with Type 59 tubes. Plate voltages considerably higher than recommended for tuned-plate type oscillators may be used — 400 to 500 volts on the 59 oscillator, for instance — and even higher voltages on screen-grid tubes having really small grid-plate capacity.

Use a crystal holder properly designed for good heat transfer and distribution. This can be done best by employing a mounting having a large mass of copper or brass for the bottom plate of the holder. The action is briefly this: Heat generated by the oscillation of the crystal is dissipated rapidly by the metal bottom plate of the holder due to the high thermo-conductivity of the metal used and the fact that the quartz rests directly on the metal with its greatest surface area contacting it. Therefore, the bottom plate resists any sudden change in temperature of the crystal; and the quartz, because it does contact the metal, will tend to remain at the same temperature as the metal. Because of its mass of metal, the lower plate temperature will tend to be the same as the average room temperature. The temperature of the metal may actually be more constant than the room temperature.

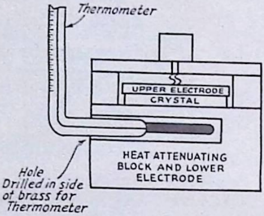

Thermometer
UPPER ELECTRODE
CRYSTAL
HEAT ATTENUATING BLOCK AND LOWER ELECTRODE
Hole Drilled in side of brass for Thermometer

FIG. 23 — THE ADDITION OF THE THERMOMETER FOR TEMPERATURE CHECKING

A comparatively large upper plate made of brass may also be used to good advantage, provided that the weight of this upper electrode is not so great as to materially dampen the oscillation of the crystal. High-frequency crystals, however, are as a general rule quite vigorous oscillators and they will stand considerable pressure from the electrodes before their oscillations are seriously dampened.

With the type of crystal holder shown in Fig. 22 the writer has eliminated any noticeable frequency shift in the carrier of W9BKO on the 14-mc. band, even after several hours of intermittent transmitter operation, provided that the room temperature stays constant within two or three degrees Fahrenheit — which it does most of the time.

Where an amateur must park on the very edge of the band (why is it that some fellows are serious in their belief, and will argue for hours, that they do not get out half as well on 7020 as on 7000.5 kc.?) it is suggested that in addition to the holder precautions given above, the scheme shown in Fig. 23 be followed. This shows a hole drilled in the side of the bottom plate of the holder just large enough to insert the thermometer immediately under that portion of the plate upon which the crystal rests. The thermometer now gives us a good comparative check on the temperature of the crystal from one operating period to the next. Then, if the temperature reading is considerably different from that previously determined by test to give operation sufficiently within the band for safety's sake, the operator will have a satisfactory visual warning to *stay off the air* until the temperature reading returns to that value where he can start up without worrying about whether or not he is in the band. Either straight or right-angle thermometers can be used, and it makes no difference whether the thermometer is calibrated in Centigrade or Fahrenheit — all we are interested in is a comparison of readings.

It is evident that, whether the crystal is to be used in an oven or without one, the use of a large quantity of brass or copper in its holder construction will be found extremely beneficial in stabilizing its temperature.

Good frequency stability is entirely possible and practical in crystal-controlled amateur transmitters without the use of expensive accessory apparatus, provided that the transmitter is in a room subject only to normal room temperature variations, that the circuit is properly adjusted and the crystal oscillator run at low excitation, and that the holder in which the crystal is mounted is designed for good heat conductivity and attenuation. Frequency stability exceeding that required for amateur work is possible under these conditions. — *E. L. Dillard, W9BKO*

—···—

More on Silvering Crystals

RECENTLY I came into the possession of a 160-meter crystal which was supposed to double into the 80-meter c.w. band. But for some of those reasons that we can't account for, it didn't.

Past numbers of *QST*[1] had said that the frequency of crystals could be lowered by silvering, so a formula was found that sounded good and the process started. *QST* said that 20- and 40-meter crystals had been done successfully, but no one has handed out anything on 160-meter crystals that I have seen. Anyway, we put on five coats and tried her out. From scratch of 3935 kc., a perceptible but small change was noticed; maybe 5 kc. What a bright outlook, when some of our 20-meter friends had made 20 kc. per coat! Circumstance called for it, therefore we kept on; and after about twenty-five coats we pushed her over for a touchdown, and no more QRM to the noble 'phones! It is my idea that the ratio of the thickness of the coat of silver to the thickness of the crystal is the answer to why one coat here makes so little progress as compared to that made by one coat on a 20-meter crystal.

It is not as bad as it sounds, however, for the formula used would put a coat on in about three minutes, and in another minute the next coat was being applied. This formula was cut down from a five-gallon job, but works nicely:

SOLUTION NO. 1

A — Dissolve $NaOH$ (sodium hydroxide)	1.13 gm.
Distilled water	180 c.c.
B — Dissolve $AgNO_3$ (silver nitrate)	1.13 gm.
NH_4OH (ammonia)	120 c.c.

Add *A* to *B*, then add 2.5 c.c. NH_4OH more to clear solution.

SOLUTION NO. 2

A — Distilled water	23.6 c.c.
Sulphuric acid	2.0 c.c.

---

[1] *QST*, March, 1932; February, 1933.

B — Distilled water	95.4 c.c.
Cane sugar	17.8 gm.

Bring B to a boil, add 2.25 c.c. of A and boil 15 min. Filter out precipitate and this is Solution No. 2.

PROCEDURE

Add 2 c.c. of No. 2 to 20 c.c. of No. 1, and as soon as it is a good amber color pour over the crystal (which we suspended in an evaporating dish on ivory pointed tweezers) and leave until the solution turns a muddy brown and looks thick. Remove, wash in distilled water, and put on another coat.

Before silvering, a third solution called "tin stock" was applied to the crystal after it had been thoroughly cleaned. This was washed off with distilled water before the first application of silvering solution. I suppose it was a filler. It was made up of 1 gm. $SnCl_2$ (tin muriate) to 200 c.c. of distilled water. It does not keep well, but is only used in starting to silver.

After the silvering was finished the edges of the crystal were ground down with fine grinding compound and cleaned with carbon tetrachloride. All results seem to be equally as good as those obtained with the bare crystal, and if ever we are fortunate enough to get into 80-meter 'phone a little nitric acid will clean it with far less effort than it took to put it on.

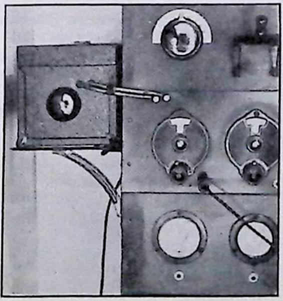
— *Fred D. Armes, W1GMD*

—···—

An Inexpensive Temperature-Control Oven

The temperature-control oven shown in the accompanying photograph has been in use at W9AA for more than eight months and has proven satisfactory in every respect. The entire cost, excluding the crystal holders and the three-way switch, was under six dollars.

The outer case of the oven is a black crystalline-finish metal tool box which can be purchased for about a dollar. Remove the leather handle and inner tool tray and line the box with three layers of half-inch insulating Masonite Presdwood or similar soft fibrous composition which can be secured from any good lumber dealer. Cut pieces of the lining to fit the bottom and sides snugly and force them into place. They will need no other fastening. Arrange the top pieces so they can be removed without too much trouble. After lining the box the metal tool tray can be cut with a hacksaw to make a base for the apparatus inside.



THE CRYSTAL OVEN MOUNTED IN PLACE ON THE TRANSMITTER

The selector-switch knob and the crystal leads come through the front.

The thermostat and heater unit can be bought from any dealer in tropical fish and aquarium supplies. The heater unit is encased in a glass tube filled with sand and can be placed directly on the bottom of the tray. Remove the glass tube from the thermostat and mount it upright so that the adjusting screw can be reached by a screw driver through a small hole in the inner top insulation.

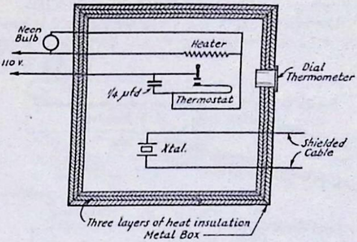


FIG. 24 — WIRING OF THE TEMPERATURE-CONTROL OVEN

The selector switch and additional crystals used by W9AA are not shown. The switch is desirable if more than one crystal is to be used.

A cheap dial type thermometer can be mounted in a hole in the inner top insulating piece. The intermediate insulating piece should have a small hole cut over the thermometer dial and a hole should also be cut over the thermostat screw, so that in reading and adjusting the temperature it is only necessary to open the cover and lift out the top layer of insulation.

This oven contains three crystals mounted in standard plug-in holders, selected by a Yaxley two-pole three-position switch. The switch is mounted inside with an extension handle through the front of the oven. Leads to the switch and crystals are made of auto ignition cable, also run through the front.

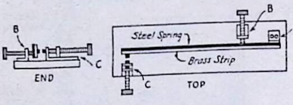
Be sure to include the ¼-µfd. (or larger) condenser shown in the diagram, Fig. 24, to prevent sparking at the contacts, or you will be unable to hear anything less than an S9 signal. A neon bulb connected across the heater is a convenience to show that the oven is working properly. A temperature of 100 degrees Fahrenheit can be maintained continuously and economically as the heater costs not more than a few cents per month to operate.

—*C. T. Read, W9AA*

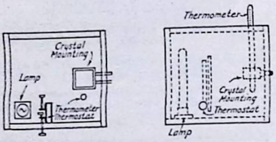
Home-Made Temperature Control Box

FIG. 25 shows the details of construction of an inexpensive heater box for crystal control as used by Fred Mueller, ex-W6EHO.

The box is 6¾ x 8¼ x 8¼ inches, and is constructed of Celotex. Screws are used for holding the sides together, and all joints must be tightly closed to prevent heat leakage.



Detail of Thermostat



Arrangement of Box

FIG. 25

Perhaps the most interesting feature of the box is the homemade bi-metallic thermostat. A six-inch piece of steel spring taken from an old alarm clock and a piece of strip brass of the same size are held together by brass rivets spaced a quarter inch apart along the length of the two pieces, forming the expansion strip. As shown in the top view of the thermostat in Fig. 25, one end of the strip is held to a suitable base by the brass angle *A*; at the other end of the strip a contact point (points from ignition coils will do very well) is rivited on the brass side. A second contact point is riveted on a spring brass angle, *C*, which also is fitted up with a machine screw as shown in the end view to vary the gap between the points. A third angle, *B*, holds another machine screw which adjusts the position of the thermo-strip in relation to the contact *C*.

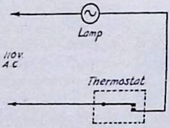


FIG. 26

The lower part of Fig. 25 shows how the parts are arranged inside the box. The thermostat is mounted vertically on one side of the box with the screw *C* projecting through so adjustments may be made from outside. The lamp which furnishes the heat is one of the type used in music racks or show cases, and is mounted so that the thermostat is between it and the crystal mounting. A 0–100 degree Centigrade thermometer is mounted near the crystal as shown in the drawing. The wiring diagram is shown in Fig. 26.

In adjusting the thermostat the screw *B* is first set so the contact points are not quite touching (this adjustment may need to be changed slightly after the strip has been heated). Screw *C* is then set so the box operates at the desired temperature, a procedure which may take a little time since the air inside the box does not reach a steady temperature immediately.

A box of this type, while not capable of maintaining the crystal temperature within the small limits allowable for precision frequency work, is adequate for general amateur work where the chief job of the oven is to compensate for variations in room temperature so that the crystal will not wander kilocycles from its nominal frequency.

—···—

Those fancy "tune for greatest swing" meters which have a moving shadow for an indicator and sell for about six bits really set off the small transmitter whose owner cannot afford a flock of Westons. They can be used to measure relative amounts of excitation when put in series with the grid bias of each amplifier stage. Several different full-scale deflections are available. They can be adapted to tubes drawing heavy grid current by providing them with shunts. — *W6BCX*

4

'Phone Working

Grid Leak Modulation

MODULATION by varying the grid-leak resistance (using a vacuum tube as the leak) while occasionally mentioned in radio literature, is not generally used because in inexperienced hands it is prone to give non-linear modulation. However, once the proper operating conditions are found, good results are possible. O. H. Huston, W9BUZ, has worked out a good combination for grid-leak modulation of 46's, and writes as follows concerning it:

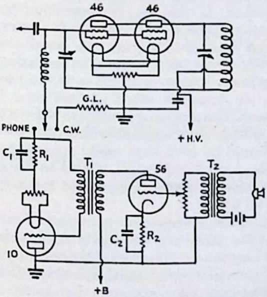


FIG. 1 — GRID-LEAK MODULATION OF 46s
The method of operation is described in the text.
C_1, C_2 — 1 µfd.
R_1 — 1500 ohms, 5-watt.
R_2 — 2500 ohms, 1-watt.
T_1 — Audio transformer, 3:1.
T_2 — Microphone transformer.

"This system has an advantage over the usual grid-bias modulation system because it requires no bias supply and eliminates one transformer. It is very simple to adjust and the quality is excellent.

"The r.f. section is the usual c.w. rig using parallel 46's in the last stage, but with the grid resistor replaced by the modulator tube and its biasing resistor, as shown in Fig. 1. After considerable experimenting it was found that the only tube which would give more than mediocre quality as a modulator for 46's was a 10. The characteristics of the two tubes apparently complement each other in such a way that, while neither is linear by itself under these conditions, the resultant antenna current plotted against grid voltage on the modulator forms a straight line which is very nearly perfect.

"To put the rig into operation only two steps are necessary. First: With the s.p.d.t. switch in the c.w. position tune the set for *maximum possible* antenna current and note its value. The output obtained at this point represents the power on the positive peaks of modulation and may be well in excess of the capabilities of the tubes for c.w. operation. Plenty of excitation will be required. Second: With the switch in the 'phone position adjust the excitation until the antenna current is one-half its former value. Turn up the gain control and start talking."

As always, the plate current of the modulated stage should be steady with modulation. A slight flicker on the modulation peaks is all that should be tolerated. W9BUZ uses a 5000-ohm variable resistor as a grid leak in the driver stage (a single 46) as the excitation control.

Those interested in modulating other types of tubes (W9BUZ has found the zero-bias types best for this sort of service) should follow the same procedure to determine proper operating conditions; that is, a curve of antenna current against modulator grid voltage should be plotted to determine the linearity of the tube combination used. Modulation should be confined to the straight portion of such a curve.

Plate Modulation With Tapped Choke

AN INTERESTING suggestion in connection with Heising modulation is offered in the following letter from D. T. Broadhead, W8CXI, of Jamestown, N. Y. It may prove of value to 'phone men using Class-A modulators, especially when confronted with Class-C amplifier plate-voltage problems such as W8CXI describes.

"I have worked out a modification of the conventional Heising modulation circuit which I believe will be helpful to many who are using this system.

"The idea is simply to convert or build a choke to act as an auto transformer by taking out a tap for the modulator plate at a point 30% to 50% down from the end of the coil, as shown in Fig. 2. The proper location of the tap (in turns from the plate-supply end of the choke) may be found as follows: Tap turns=

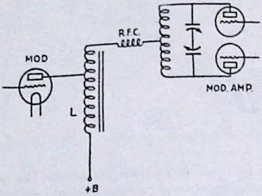


FIG. 2 — THE CHOKE, L, IS TAPPED TO WORK AS AN AUTO-TRANSFORMER SO THAT BOTH MODULATOR AND MODULATED AMPLIFIER CAN OPERATE AT THE SAME D.C. PLATE VOLTAGE

$$\frac{\text{Modulator plate swing volts (peak)}}{\text{total plate voltage}} \times$$

total turns.

"The modulator plate swing can be found from the load line plotted on the familiar plate-current plate-voltage curves for the tube in use, using the formula:

$$\text{Plate swing volts} = \frac{E_{max} - E_{min}}{2}$$

"If the maximum undistorted output of the modulator at the operating voltage and current have been ascertained, then the plate current to the final r.f. amplifier is simply:

$$\frac{\text{Watts (audio)} \times 2}{\text{plate voltage}}$$

"Several advantages result from the use of this method. It eliminates nuisance of the dropping resistor, which wastes from 35% to 50% of the d.c. power supplied to the modulated amplifier; the drain on the high voltage plate supply is reduced; and finally, it permits the operation of high-voltage low-current tubes such as the 852 at full voltage.

"The modulator here is an 851, which at 2500 volts and 240 ma. has an output of 165 watts audio power. The plate swing is 1375 volts, hardly enough to operate a pair of 852's at good efficiency, and requiring a plate current of 240 ma., using the dropping resistor method. Now with 2300 volts audio swing the 852's may be operated at full voltage and only require about 140 mils for the same carrier. The total plate current requirement has been reduced from 480 to 380 ma., making the use of an 866 bridge rectifier practical.

"It is usually preferable to allow the carrier power to be a little more than twice the audio output, then if the gain is held below the point where the modulator kicks up there is little danger of overmodulation, provided the r.f. amplifier is properly excited."

Choke-Coupled Modulation of R.F. Pentodes

SIMULTANEOUS plate and screen modulation of an r.f. pentode, can be applied to Class-A choke-coupled modulation systems by the use of an appropriately-tapped modulation choke or two chokes in series. This method, suggested by A. D. Mayo, Jr., W4CBD, is shown in Fig. 3.

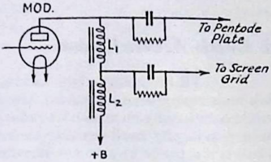


FIG. 3 — CLASS-A CHOKE-COUPLED SCREEN AND PLATE MODULATION OF AN R.F. PENTODE

The audio-frequency voltage divides across the two chokes, L_1 and L_2, in proportion to their inductances. The resistor and condenser in series with the pentode plate are the usual dropping resistor and by-pass to adjust the operating plate voltage in accordance with the modulator requirements, as described often in *QST* and in the *Handbook*. The dropping resistor in series with the screen grid performs a similar function; its resistance should be such that under operating conditions the proper voltage is applied to the screen. The by-pass condenser may be in the neighborhood of 2 μfd.

With most screen-grid pentodes, where the ratio of d.c. plate and screen voltages is approximately four to one, the ratio of choke inductances, L_1 to L_2, should be the same or higher. That is, if L_1 is 30 henrys, for example, L_2 should be between 5 and 8 henrys.

—···—

Suppressor Modulation With Linear Amplification

AS A means for getting on 'phone with a minimum of equipment, Charles Lober, W8ICO, has found the arrangement shown in Fig. 4 to be highly effective. The transmitter is a typical 100-watt (nominal) c.w. layout using a 47 crystal oscillator, RK23 buffer, and heavy-duty 203-A final. Ordinarily in such a rig the final would be modulated either with Class-B audio or by the grid-bias system. In this case, however, the pentode driver tube is suppressor-modulated, the final stage being used as a Class-B linear amplifier. The carrier output is about equivalent to that obtainable with grid-bias modulation of the final, but with less rigorous biasing and audio power requirements.

In connection with adjusting the set for 'phone, W8ICO writes:

"The transmitter is tuned up in the ordinary manner. Grid current will be much lower for the final than with the usual Class-C amplifier. Input should be adjusted so as to be about 30% more than the rated tube dissipation. The higher the tube plate dissipation, the greater the input that can be used.

"Then negative suppressor voltage, which may be obtained from a 'B' eliminator or bias batteries, is applied. Then, while watching the antenna ammeter, the variable resistor R_5 is swung to make the suppressor negative (a potentiometer should be used to give smooth adjustment of grid voltage). Set the bias so that the antenna current drops 50%.

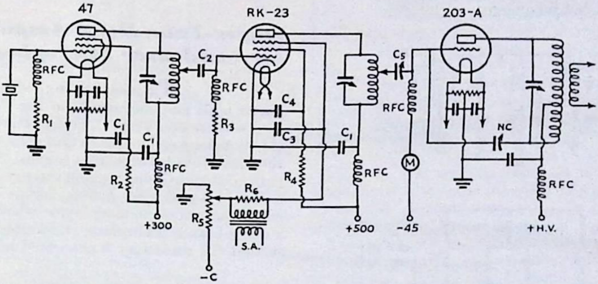


FIG. 4 — THREE-STAGE 'PHONE TRANSMITTER WITH SUPPRESSOR MODULATION AND LINEAR AMPLIFICATION

C_1 — 0.004 μfd.
C_2 — 250 μμfd.
C_3 — 0.002 μfd.
C_4 — 0.001 μfd.
C_5 — 350-μμfd. variable.
R_1 — 7000 ohms.
R_2 — 50,000 ohms.
R_3 — 2000 ohms.
R_4 — 20,000 ohms, 10 watts.
R_5 — 50,000 ohms, variable.
R_6 — Load resistor for modulator.

"Some minor adjustments of excitation may have to be made, hence the variable condenser C_5. If antenna current does not show normal modulation increase, this probably will mean the buffer isn't being modulated heavily enough so excitation should be increased. This in turn will require more negative voltage to be used to cut down antenna current; making the buffer easier to modulate.

"The modulator used here is a double-button microphone with a 24 speech amplifier and a 56 modulator.

"A carrier of approximately 55-60 watts can be realized with 1250 volts at 190 ma. on the plate of the final."

In the adjustment of such a system the aim should be to attain normal operating plate currents and biases simultaneously on both modulated stage and linear amplifier. The operating data furnished with the tubes should be consulted. An alternative method of adjustment is as follows: Disconnect the final from the pentode driver, apply rated plate and suppressor voltages for suppressor modulation, and couple a dummy antenna to the pentode tank circuit, adjusting the coupling until the tube draws the specified plate current. A modulation test will show whether or not this stage is working properly. When satisfactory operation is secured, apply plate voltage and rated bias for Class-B r.f. amplification to the final stage, couple on the driver, and adjust the interstage coupling to make the pentode draw the proper plate current. Then adjust antenna coupling to obtain rated plate current (for Class-B conditions) on the final stage. If the excitation is correct, the antenna current will show an upward kick of five to ten percent with modulation and the final stage plate current will be steady. Should the plate current kick downward when modulating, the excitation must be reduced to the point where there is no change in plate current or, at most, a very slight upward kick. As excitation is reduced, the antenna coupling must be adjusted to keep the final plate current at the same value. Should the driver plate current drop when these changes are made, some resistance should be connected across its tank circuit to bring the plate current back to its normal value. A non-inductive resistor is preferable; it need be rated at only five watts or so and should have a value in the vicinity of a few hundred ohms. The loading can be adjusted by varying the number of tank turns across which the resistor is connected. The additional loading not only provides a means for reaching the proper operating conditions on both modulated stage and amplifier, but also improves the operation of the circuit as a whole by improving the r.f. regulation in the grid circuit.

It is advisable to connect a by-pass condenser (1 μfd. or more) between the movable arm of R_5 and ground to shunt out the potentiometer resistance for audio in the suppressor circuit.

Preventing Oscillation in R.C. Amplifiers

S. J. Preston, B.A., writing in "World-Radio," points out that a resistance-coupled audio amplifier can give trouble from motorboating even when decoupling resistors and condensers are used. This trouble can be eliminated by choosing a grid blocking condenser and grid leak for the following stage such that their time constant is equal to that of the plate resistor and by-pass condenser. If this is not done, there is a chance that the gain at low frequencies will rise to such an extent that regeneration and oscillation can take place.

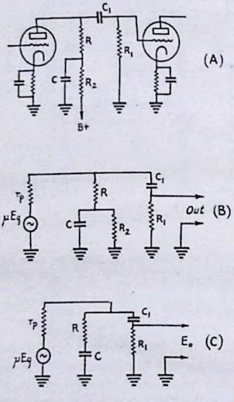


FIG. 5 — RESISTANCE-COUPLED AMPLIFIER EQUIVALENT CIRCUITS

Fig. 5A is the usual resistance-capacity arrangement when a decoupling resistor, R_2, is used. Now R_2 is usually high enough not to affect the by-passing operation of C. We then have a plate load consisting of R and C in series, the impedance of which combination varies inversely with frequency (see Fig. 5B) so that at low frequencies the gain becomes so great that if there is positive feedback, even though small, the amplifier starts to motorboat. This tendency could be eliminated by making C very large or by reducing R_2, but doing the latter would affect the decoupling and get one into more feedback trouble.

When R_2 is large enough to be neglected the equivalent circuit will be as in Fig. 5C and E_0 will be equal to

$$\frac{\mu C_1 R_1}{r_p C} \times \frac{1 + j\omega CR}{1 + j\omega C_1 R_1} \times E_{input}$$

so that if C_1R_1 and CR are equal, E_0 will be constant at all frequencies.

Now, the trick is to make them equal. If R is 250,000 ohms and C is 0.5 μfd., CR is .125, and if C_1 is .06 μfd. and R_1 2 megohms, C_1R_1 is also about .125, and you can use as big a decoupling resistance as other considerations will allow, without getting boominess or motorboating.

Decoupling circuits are likely to cause undue low-frequency gain in choke- or transformer-coupled circuits unless something else causes a loss of low-frequency gain at the same time.

— *H. S. Gowan, Stratford, Ont.*

Single-Tube Head Amplifier for Condenser Microphone

The single-tube condenser-microphone head amplifier shown in Fig. 6 has been used with success by R. G. Sceli of Hartford. The gain is at least equivalent to that obtainable from the usual cascaded resistance-coupled 30's, a large voltage step-up being secured through the use of a 32 screen-grid tube. A novel feature of the circuit is the output coupling device, which is simply a single-button microphone transformer reversed so that the secondary is connected in the plate circuit and the primary used as an output winding to work into a low-impedance line. To avoid having the plate current flow through the secondary, with a consequent reduction in inductance, the plate voltage is fed to the tube through a 250,000-ohm resistor, the transformer being coupled to the plate through a 0.1-μfd. condenser. The 1-volt drop across a 16-ohm resistor in series with the filament of the tube is utilized as grid bias.

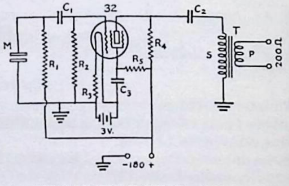


FIG. 6 — SINGLE-TUBE HEAD AMPLIFIER FOR CONDENSER MICROPHONE

C_1 — *0.01 μfd.*
C_2 — *0.1 μfd.*
C_3 — *0.25 μfd.*
R_1, R_2 — *5 megohms.*
R_3 — *16 ohms.*
R_4 — *250,000 ohms.*
R_5 — *75,000 ohms.*
T — Single-button microphone transformer.
M — Condenser microphone head.

An amplifier of this type offers savings in both space and cost.

A.C.-Operated Pre-Amplifier

The circuit shown in Fig. 7 is not original at all, but inasmuch as it has served to operate both dynamic and condenser-type microphones "all a.c." — with ridiculously low hum — I offer it for what value it may have to "ye hamme." Use can be made of the power supply already operating the main speech amplifier.

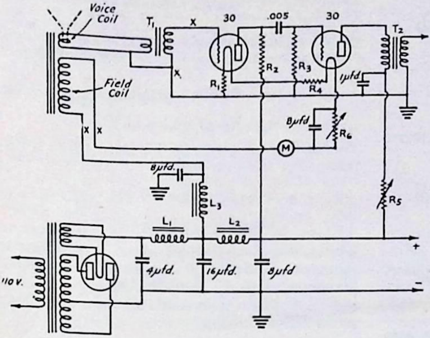


FIG. 7 — A.C.-OPERATED PRE-AMPLIFIER WITH DYNAMIC MICROPHONE

R_1 — 75 ohms.
R_2 — 100,000 ohms.
R_3 — 250,000 ohms.
R_4 — 40 ohms.
R_5 — 250,000-ohm variable resistor.
R_6 — 5000-ohm variable resistor, wire-wound.
L_1 — 45-henry, 125-ma. choke.
L_2 — 45-henry, 40-ma. choke.
L_3 — 30-henry, 85-ma. choke.
M — 0-100 d.c. milliammeter.
T_1 — Microphone transformer.
T_2 — Output transformer to 500-ohm line.

The idea is simply this: Rectified and filtered d.c. from the plate supply is reduced in voltage by suitable resistors to furnish power for the filaments of Type 30 or other low-voltage pre-amplifier tubes. Filament current is adjusted by varying R_6 until the milliammeter, M, reads the correct value for the tube filaments — in the case of 30's, 60 mils. Since the filaments are in series, R_6 always should be adjusted for rated current flow of *one* tube; furthermore, the tubes in the amplifier should all be rated to take the same filament current. Resistors R_1 and R_4 provide the grid bias for the two tubes; L_3 is a decoupling choke. The other circuit values are those usually to be expected in similar amplifiers.

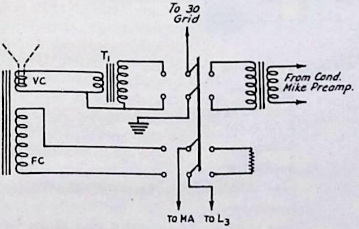


FIG. 8 — A SWITCHING ARRANGEMENT TO USE THE AMPLIFIER OF FIG. 7 WITH A CONDENSER MICROPHONE HAVING AN ADDITIONAL STAGE OF PRE-AMPLIFICATION

If a twin d.p.d.t. switch is inserted at the points marked "X", arranged so that a resistor of 1800 ohms replaces the field coil of the dynamic speaker (or a resistor having the same value as the field coil resistance), a condenser microphone can be used in place of the dynamic. Fig. 8 shows this more clearly. A single stage of condenser mike pre-amplifier is all that is required in addition to the two stages shown. If the condenser mike is sensitive enough it might be used directly, with suitable switching of the head connections. If the filament of the condenser mike pre-amplifier is also in series with the other filaments, the milliammeter should still read 60 mils.

An arrangement of this sort reduces materially the cost of operating and maintaining a condenser or dynamic microphone. It has been used by W9BHM and W9AAI for a number of years. Its recent inauguration at W9JHY has sold me 100% on the idea. — *M. C. Bartlett, W9JHY*

—···—

A.C. Pre-Amplifier for Condenser Mike

The circuit diagram of Fig. 9, an all a.c.-operated head amplifier for a condenser microphone, has been used very successfully by Fay Harwood, W6BHO, Santa Paula, Calif. Standard 2.5-volt tubes are used, and humless amplification is secured with a well-filtered power pack. W6BHO uses a regular National type 5880 supply.

The first tube is a 2A6, which is combination tube having a triode with an amplification factor of 100 and a pair of diode plates, the latter being unused in this case. The second tube is a 56. Resistance coupling is used from the microphone up to the output of the 56, where a transformer couples the amplifier to a 500-ohm line.

The entire amplifier is enclosed in a metal box, with a metal shelf inside for mounting the tubes. Grid leads should be as short as possible. The a.c. leads inside the box are in shielded cable with the shields grounded; the four external power-supply leads are in a single cable, also shielded. A good grade of resistors and mica coupling condensers must be used to prevent noise. It should be noted

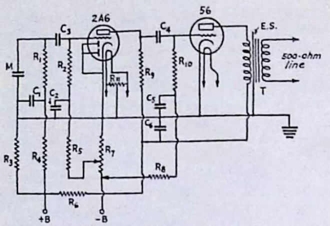


FIG. 9—AN A.C.-OPERATED HEAD AMPLIFIER FOR A CONDENSER MICROPHONE

M—Microphone.
C_1, C_2—0.5 μfd.
C_3—0.005-μfd. mica condenser.
C_4—0.01μfd. mica condenser.
C_5, C_6—.5 μfd.
R_1, R_2—250,000 ohms.
R_3—20,000 ohms.
R_4—1 megohm.
R_5—250,000 ohms.
R_6—20,000 ohms.
R_7—1000-ohm semi-variable resistor.
R_8, R_9—250,000 ohms.
R_{10}—1 megohm.
R_{11}—20 ohms, center-tapped.
T—Tube-to-line transformer, 500-ohm output, with electrostatic shield.

that the negative "B" lead should not be grounded, since there is a potential difference of several volts between it and the common ground for the amplifier, which is attached to the tube cathodes.

The 1000-ohm bias resistor, R_7, should be of the semi-variable type. W6BHO uses a 25-watt Electrad resistor with the sliders set to put 1.3 volts bias on the 2A6 grid, and 13 volts on the 56 grid. The bias adjustment should be made with the aid of a high-resistance voltmeter.

—···—

Volume Control in Terms of Decibels

IN MOST amateur 'phone transmitters the voltage-divider type of volume control is used. A simple method of graduating this type of volume control in terms of decibels is as follows:

It is known that attenuation varies according to the following formula:

$$\text{db} = 20 \log_{10} \frac{E_1}{E_2}$$

But since the voltage drop across a resistance is directly proportional to the resistance we may write:

$$\text{db} = 20 \log_{10} \frac{R_1}{R_2}$$

where R_1 and R_2 are as shown in the diagram, Fig. 10.

For example, suppose we wish to make a voltage-divider type volume control which has steps of 2 db for a type 56 or 27 tube. The total resistance, R, is usually around 100,000 ohms. Transposing we get

$$\text{db}/20 = \log_{10} R_1 - \log_{10} R_2$$

$$\text{or, } \log_{10} R_2 = \log_{10} R_1 - \frac{\text{db}}{20}$$

Substituting in this last formula the known values of 2 db attenuation and R of 100,000 ohms we get:

$$\log_{10} R_2 = \log_{10} 100{,}000 - \frac{2}{20}$$

$$\log_{10} R_2 = 5 - 0.1 = 4.9$$

The antilog of 4.9 is 79,430 ohms (from a log table). For the 4 db loss:

$$\log_{10} R_2 = \log_{10} 100{,}000 - \frac{4}{20}$$

$$\log_{10} R_2 = 5 - 0.2 = 4.8$$

The antilog of 4.8 is 63,090 ohms. This process is repeated on down till the required loss is a maximum. Usually a 20-db loss is more than sufficient. The results tabulated for a 20-db loss are as follows:

DB loss	R_2
2	79,430 ohms
4	63,090 "
6	51,900 "
8	39,810 "
10	31,620 "
12	25,110 "
14	19,950 "
16	15,840 "
18	12,580 "
20	10,000 "

Thus if we take a wire-wound resistor and bring out taps at the designated points, uniform steps of loss will be obtained when the volume control is used. The advantage of this is that we know just how much loss is introduced and we can turn to that loss at any time so that the excitation does not vary every time one goes on the air. If music is to be faded in and out, the taps will have to be right on the resistor so that the grid will not be free between taps. However, the slider can run directly on the resistor and stops be stationed so that the pointer arm stops at the right value of resistance. If a value of resistance other than 100,000 ohms is used the process is re-

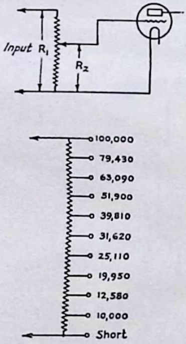


FIG. 10—THE VOLUME-CONTROL CIRCUIT AND THE TAPPED RESISTOR WHICH GIVES A TOTAL OF 20 DB ATTENUATION IN STEPS OF 2 DB

peated, using the new value of resistance in the place of 100,000. — *Walter Fliegner, W6AST*

Editor's Note — The values given in the table can be used as percentages to determine the correct point at which to place taps on resistors having a total resistance other than 100,000 ohms. For example, to get 2 db loss the tap should be placed at 79.4% of the total resistance; for 4 db loss the tap would be at 63% of the total resistance, etc. A chart giving a calibration for any voltage divider is shown in the article, "What is This Thing Called Decibel?", in August, 1931, *QST*.

—···—

Mixing System

The circuit of Fig. 11, for mixing inputs from various sources, is contributed by Charles M. Dibrell, W5BLW, with the thought that it will be of interest to hams doing P.A. work and possibly also to 'phone men. He writes, "With this method . . . several sources, such as microphones and phono pickups, can be mixed without the necessity for expensive constant-impedance volume controls for each channel. Ordinary 500,000-ohm potentiometers are used in each grid circuit, and the variation of any one control has no noticeable effect on volume or frequency characteristics of the others regardless of their settings. Thus a music background for speech is easily obtained. Any number of channels could be used, as well as other types of tubes. One of the twin tubes like the 53 might be used with two channels."

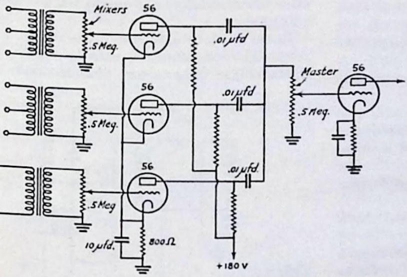


FIG. 11 — AN INEXPENSIVE MIXING SYSTEM FOR AUDIO AMPLIFIERS

The plate resistors are each 100,000 ohms.

Another possibility is the use of a 6F7 tube for a two-channel mixer when it is necessary to provide more gain for one tube than the other.

—···—

Automatic Microphone Battery Switch

L. A. Stafford, W2DIB, has a good suggestion for those fellows prone to forget to turn off the mike battery when the station goes off the air. The idea is shown diagrammatically in Fig. 12. A relay is arranged with its contacts in series with the microphone battery circuit and the winding in series with the plate supply for the modulator (if Class A) or the modulated amplifier. The battery circuit is thus automatically closed when the transmitter is in operation, but opens as soon as the plate supply is cut off.

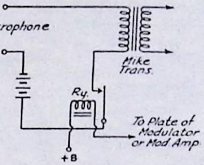


FIG. 12 — RELAY CIRCUIT FOR AUTOMATICALLY CUTTING THE MICROPHONE BATTERY CIRCUIT WHEN TRANSMITTER IS INOPERATIVE

The relay itself must be one which will operate on the plate current taken by the stage to which it is connected, and its characteristics naturally will vary with the type of transmitter in use. It is desirable that it should not introduce too much resistance in the circuit.

—···—

Magnets for the Velocity Microphone

Where to get permanent magnets for home-made velocity microphones? Here is one answer, supplied by Paul R. Smith, W8FHB, Bradner, Ohio:

"A recent issue of *QST*[1] gave data concerning the construction and operation of a ham-built velocity microphone of the permanent magnet type. This was the very thing I had been looking for, but upon invoicing my stock of parts I found nothing that would be of any value. One day, quite by accident, I found a substitute which is easy to construct and at the same time very rugged. It is the last word in simplicity since there is no machining of parts.

"The drawing of Fig. 13 shows the construction of a microphone using a permanent magnet of a special type — a drag-magnet taken from a watt-hour meter. Magnets of this type should be easily obtained by hams who are on good terms with a power company. The spacing between the poles is originally about one-eighth inch, which is not wide enough for the ribbon. Therefore the poles must be separated far enough to admit a ¼-inch bakelite strip to which the ribbon is fastened by the washer-nut combinations at each end. The mechanical tension of the magnet is ample to hold the strip permanently in position.

---

[1] Velocity Microphones—The Permanent Magnet Type February, 1933, *QST*.

"An improvement can be made by drilling the strip full of holes to allow free passage of air past the ribbon. These should be as large and as close together as possible without endangering the mechanical strength of the strip. A tinfoil ribbon is in use at W8FHB. It can be made quite accurately if a little time and patience are used in shaping it.

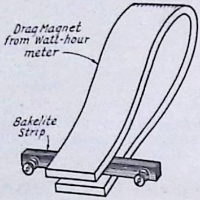


FIG. 13—SIMPLE VELOCITY MICROPHONE USING A DRAG-MAGNET FROM A WATT-HOUR METER

The ribbon, not shown, is suspended between the machine screws at the ends of the bakelite strip.

"No means of checking the quality is available here except the usual ham method of hooking it up and listening. However, on various musical tones, all appear to register equally well. The mike-to-grid transformer described in a former *QST* is used in this rig."

A similar use for another type of watt-hour meter magnet was suggested independently by E. R. Patchen, of Lakeville, Conn. A sketch of a magnet of this type is shown in Fig. 14. These measure approximately 2½ inches by 2 inches, and the bar is about 5/16-inch thick. The gap is too small to accommodate a ribbon of ordinary construction and must be widened to ¼-inch by cutting off a small portion of the vertical arm. This may be done with a carborundum wheel.

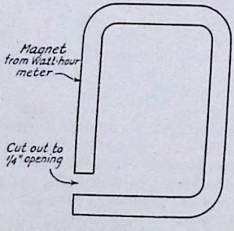


FIG. 14—A SECOND FORM OF WATT-HOUR METER MAGNET WHICH ALSO CAN BE USED IN THE CONSTRUCTION OF HOME-MADE VELOCITY MICROPHONES

In making the microphone a number of the magnets are stacked to take care of the ribbon length used. They may be clamped together in any convenient fashion. It is necessary to check the polarities, since the magnets are furnished in pairs for each watt-hour meter and the individual magnets of each pair are oppositely polarized. Mr. Patchen states that most power companies have plenty of these magnets on hand, since they are frequently removed from meters brought in for checking and recalibration.

—. . . —

The Absorption Condenser Microphone

A MODIFIED version of the absorption condenser microphone,[1] in which the inherent stability of the electron-coupled oscillator is utilized, is shown in Fig. 15. This circuit was adopted in an effort to eliminate the critical tuning and unstable operation of most types of absorption circuits, and meets the requirements admirably.

Little need be said about the circuit components. The condenser microphone capacity *CM* is in the control grid circuit, while the plate circuit is tuned slightly off resonance. When a sound wave strikes the microphone diaphragm the fluctuating capacity of *CM* causes the radio frequency of the control circuit to vary at the applied audio frequency, and this in turn pro-

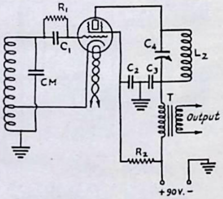


FIG. 15—THE CONDENSER MICROPHONE VARIES THE OSCILLATOR FREQUENCY, CAUSING AUDIO-FREQUENCY VARIATIONS IN PLATE CURRENT

An oscillator frequency outside an amateur band should be chosen to avoid heterodyning. W6BJE uses 6000 kc. The inductance of the coils L_1 and L_2 will depend upon the frequency chosen.

CM — Condenser microphone head.
C_1 — 250 μμfd.
C_2 — 0.001 μfd.
C_3 — 100 μμfd.
C_4 — 50-μμfd. midget variable.
R_1 — 50,000 ohms.
R_2 — 10,000 ohms.
T — Tube-to-line output transformer, input impedance 18,000 ohms.

---

[1] Experimenters' Section, July, 1932, *QST*.

duces corresponding audio frequency variations of the plate current by reason of the fluctuating resonance point. The output equals or exceeds that of a double-button microphone.

Either an a.c. or d.c. filament type tube may be used, and well-filtered r.a.c. is thoroughly satisfactory as the plate supply. A frequency in the vicinity of 6000 kc. is used to avoid heterodyning with transmitter frequencies or incoming signals. I am unable to say how nearly linear the plate-current curve is, but the quality obtainable sounds excellent, while the ease and stability of operation is a relief after experiencing the annoyances associated with other types.

— *Cecil Lynch, W6BJE*

—···—

A Simple Volume Indicator

Those of us who are looking for a simple but effective volume-level indicator may find the one described here, developed for a public address system, of interest. Use is made of a 56 tube biased to cut-off, with a 0-1 milliammeter in the plate circuit as an indicator, as shown in the diagram, Fig. 16. The system takes its heater and plate power from the amplifier on which it is used.

The design shown uses capacity-resistance input to cut down space requirements and to minimize pickup and interaction with the amplifier circuit. A better method from the response angle, however, is to use an audio transformer. It may either be connected step-up for sensitivity when the comparatively-low impedance of the primary can be tolerated in the circuit, or step-down when the circuit on which it is used must not be appreciably shunted. Using a 3:1 audio transformer as a step-down (secondary as input, primary to indicator grid), 9 volts, 60 cycles, produced a half-scale deflection.

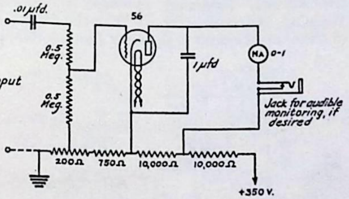


FIG. 16 — CIRCUIT OF THE SIMPLE VOLUME INDICATOR

In the hookup shown, the divider system across the input presents a high impedance to the exciting circuit and a reasonably low impedance to the grid-cathode circuit — the latter feature prevents "floating" of the indicator meter. The condenser in the plate circuit is not necessary, but helps show up the peaks and, in case the indicator is used on high audio frequencies or radio frequencies, bypasses the meter. The values shown work out nicely in my case, but should not be considered sacred.

To operate, disconnect or short-circuit the input, adjust the meter to zero or some convenient low reading by means of the potentiometer supplying the grid bias (it might be well to add that this potentiometer should be set for maximum bias at the ground end to begin with, to protect the meter), and connect the input back to the point at which the level is to be measured — or disconnect your short circuit, as the case may be.

—*P. C. Tait, W6AEA*

—···—

'Phone Monitor—V.T. Voltmeter

A combination 'phone monitor and vacuum-tube voltmeter using a single tube of the duo-diode—hi-μ triode type is shown in Fig. 17, the circuit being suggested by Wolcott Smith of the F. W. Sickles Co., Springfield, Mass. The input circuit is arranged so that the diode rectifier portion may be cut in or out of the circuit by means of the switch S_1; with the diodes cut in for monitoring, the triode section of the tube is used as an audio amplifier. Switch S_2, in the plate circuit, cuts in either the headphones, for monitoring, or the 0-1 milliammeter, for voltage measurement.

For voltage measurement the "B" supply should be 100 to 135 volts from a source having good regulation — 3% or better — such as batteries or a "B" supply of ample current capacity. Since the maximum current change is small — not over 1 milliampere — it should not be difficult to maintain sufficiently good voltage regulation with a "B" power pack. To use the tube as a

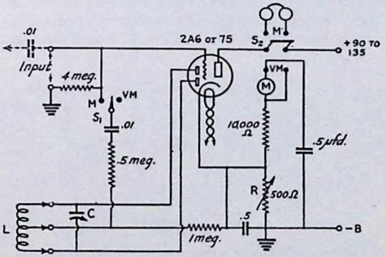


FIG. 17 — COMBINED V.T. VOLTMETER AND 'PHONE MONITOR USING DUAL-PURPOSE TUBE

For best results the lead to the triode grid should have low capacity to ground and other parts of the circuit. The milliammeter M is a 0–1 mil instrument. The 0.01-µfd. condenser shown dotted at the input terminals is used as an insulating condenser when a.c. measurements are being taken from a source which also has a d.c. potential across it.

voltmeter the 500-ohm variable cathode resistor, R, should be adjusted so that the plate current is 0.1 ma. with the input terminals shorted. With 90 volts on the plate, the milliammeter will read full scale when a signal of approximately 2.5 volts is applied to the input terminals. With 135 volts on the plate the full-scale reading will be obtained with a signal of approximately 2.0 volts. The voltmeter may be calibrated in comparison with a known source of voltage.

For monitoring, a pickup coil of suitable inductance is plugged across the tuning condenser C, the circuit being designed to resonate at the operating frequency. Constants are not critical, a 100-μμfd. tuning condenser and coils having sufficient inductance to tune to the operating frequency being suggested. A coil consisting of 40 turns of No. 24 d.s.c. or s.c.c. wire on a 1-inch form, tapped at the center, will be suitable for the 3900 to 4000-kc. band with a 100-μμfd. tuning condenser.

—···—

'Phone Monitor and Modulation Meter

The circuit diagram of the modulation meter and audio monitor used by R.C.A. in their one-kilowatt broadcast transmitters, shown in Fig. 18, should be of interest to 'phone men, since the apparatus is quite simple and inexpensive — exclusive of meters it can be built for less than five dollars. It uses two Type 80 tubes, one as an audio rectifier and the other as a modified form of volume-level indicator. The circuit constants are given under the diagram.

To put the unit into operation, couple the pickup coil L_1 to the final amplifier tank, adjusting the coupling until a reading of 26 milliamperes is obtained on M_1. The exact value of current is important and must be observed if the modulation percentage is to be read correctly on M_2. At 100% modulation (steady state conditions, constant tone input) M_2 will read 5 milliamperes.

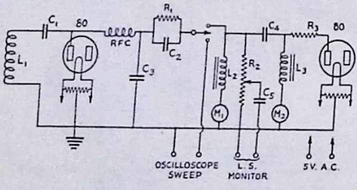


FIG. 18 — MODULATION METER AND AUDIO MONITOR

Only one plate used in each Type 80 tube.

L_1 — Pickup coil.
C_1 — .002 μfd.
C_2 — .05 μfd.
C_3 — .001 μfd.
C_4 — 2 μfd.
C_5 — 1 μfd.
R_1 — 350 ohms, 3-watt.
R_2 — 10,000-ohm.
R_3 — 2500 ohms, 3-watt.
L_2, L_3 — 30-henry chokes.
R.F.C. — Short-wave choke.
M_1 — 0-50 ma. d.c.
M_2 — 0-5 ma. d.c.

This meter can be calibrated directly in percentage modulation, since its reading is proportional to the amplitude of the audio-frequency carrier variations.

The size of the pickup coil is not critical. Anything will do so long as the rectified current as read by M_1 can be set to the correct value. The whole instrument may be built into a small box and made readily portable. The terminals marked "oscilloscope sweep" may be connected to that part of an oscilloscope if one is available. If not, the s.p.d.t. switch may be omitted.

—*J. E. Pitts, Jr., W6CQK*

EDITOR'S NOTE. — As a modulation-percentage indicator, this type of instrument is subject to the defect that its readings are dependent upon the average amplitude of the modulation envelope, whereas the *peak* amplitude is the important quantity in modulation depth measurements. The relation between the reading of M_2 and the modulation percentage will hold only when the modulation envelope is a sine wave. If harmonics are present or the modulation is complex, as with voice input, the meter reading may indicate either a higher or lower percentage of modulation than the actual. The same applies to volume-level indicators whose readings are proportional to r.m.s. values, such as current-squared galvanometers.

—···—

Automatic Carrier Switching

'PHONE operators who have fairly good superhet receivers can, by the addition of a relay or two, easily fix up an automatic switching arrangement by means of which the transmitter is put on the air as soon as the other party to a QSO cuts off his carrier. A diagram of the scheme, suggested by Fred L. Seufert, W2AOG, is given in Fig. 19. The chief essential of the control circuit is the relay Ry_1, which must be capable of operating on about .7 ma. and releasing on .5 ma. — in other words, remaining idle under normal detector plate current conditions when no carrier is being received, and operating as soon as a carrier of appreciable strength causes the detector plate current to rise. W2AOG finds a W.E. type B145 relay to be quite satisfactory.

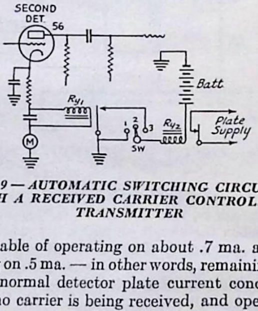


FIG. 19 — AUTOMATIC SWITCHING CIRCUIT BY WHICH A RECEIVED CARRIER CONTROLS THE TRANSMITTER

The operation of the system is as follows: With the switch Sw set at position 2, tune in a signal which causes the detector plate current to rise appreciably — say to 1 ma. Next set the switch in position 3; the power relay, Ry_2, is now in the circuit but does not operate because the control-relay armature is held open. As soon as the received carrier goes off, however, the detector plate current drops and the relay armature is released, closing the contacts and actuating the power relay, thus putting the transmitter on the air. To cut off the transmitter, move the switch to position 2. When the other fellow's carrier comes on again, the switch can be moved to position 3 and the process repeated.

For complete manual operation, the switch is moved between positions 1 and 2.

—…—

The 6E5 for Checking Overmodulation

A METHOD for checking overmodulation by the use of the 6E5 electron ray tube — the "magic eye" — is suggested by Clarence C. Moore, W9LZX. Overmodulation in either the upward or downward direction can be detected, and the gadget can be used to check incoming signals as well as one's own transmitter.

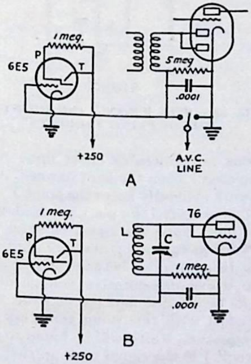


FIG. 20 — CIRCUITS FOR USING THE 6E5 FOR CHECKING OVERMODULATION

A typical application to an AVC-equipped superhet receiver is shown at A. An overmodulation indicator for transmitting is given at B.

Typical circuits for both receiving and transmitting are indicated in Fig. 20. Circuit A shows how the 6E5 can be connected into a superhet receiver using a diode rectifier. The grid of the 6E5 is connected to the a.v.c. side of the rectifier load resistor. Audio coupling is omitted in the interests of simplification although the connections in the receiver would not be disturbed. The width of the shaded area on the target is dependent upon the voltage developed across the diode load resistor and hence upon the received signal strength. On the method of using the tube W9LZX writes: "The 'magic eye,' when nearly closed on a strong carrier, has light yellowish-green edges on the two sides of the opening. With modulation there is a fuzzy appearance between these edges, but with overmodulation the two bright edges themselves will shift closer together. With downward modulation the opposite occurs. The most accurate reading is obtained when the eye is open about 40 degrees. The a.v.c. on the super cannot be used at the same time because it would compensate for any carrier shift. The audio gain control may need to be turned down while the i.f. gain is brought up high enough to get proper readings on weak stations."

Incidentally, the 6E5 can be used as a tuning meter when the a.v.c. is connected in.

For transmitting, the circuit shown at Fig. 1-B is suggested. It is equivalent to that at A except that a triode with grid and plate connected together is used as a rectifier. The tuned circuit is adjusted to resonance at the transmitting frequency. The circuit must be well shielded so that the only signal pickup is through the tuned circuit.

—…—

Duplex 'Phone

THERE comes a time in every ham's life when he feels the urge to have a two-way QSO for test purposes. There are so many details when reporting through a test transmission that most of the substance is forgotten. Regular duplex operation is not very desirable in our present crowded 'phone bands, however, especially when the transmitter is left on continuously, hence I suggest the following method to be used for test purposes only. A direct reply is obtained on each test and much time is saved.

Dig down in that old junk box and get a pair of 250- or 350-$\mu\mu$fd. variable receiving condensers of the broadcast type, also two dials and a 1½-inch diameter coil form for the plug-in coil. The system is, no doubt, applicable to any band, the frequency being about proportional to the number of turns for other bands, hence the plug-in coil. The specifications given under Fig. 21 apply to the 160-meter 'phone band.

Two turns of No. 20 rubber-covered wire are used for the pick-up coil, L_2, placed one-third of the way down from the antenna on L_1. Connections from L_2 run through a shielded two-wire cable to the antenna coil of the receiver. The antenna coil on the receiver should be disconnected from ground. Good shielding of both receiver and duplex system is essential; the shielded cable connects the common grounds. The length of the antenna is more or less optional, depending upon working conditions of the transmitter and duplex system in general. In my particular case a five-foot vertical wire was used, affording excellent selectivity without much decrease in signal level. However, up to twenty feet of antenna has been used without trouble from transmitter blocking.

The system is tuned by using the regular long receiving antenna connected directly to one side of the open antenna coil of the receiver. After the desirable station has been tuned in, the gain control of the receiver is advanced slightly and the long antenna disconnected, leaving the duplex system in operation. The condenser C_1, across L_1, is rotated slowly until maximum signal strength is obtained. C_2 is set at approximately half capacity and tuned for sharpest signal after desired frequency is obtained. No cutting and trying is necessary for specifications given herewith. It really works!

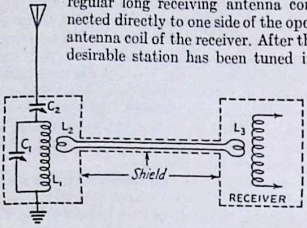


FIG. 21—SHIELDED INPUT TUNING CIRCUIT FOR WORKING 'PHONE DUPLEX

C_1, C_2—250- to 350-μμfd. variable condensers.
L_1—35 turns No. 30 d.c.c. wire, double spaced, on 1½ plug-in form.
L_2—2 turns No. 26 rubber-covered wire wound over L_1.
L_3—Antenna input coil on receiver (must be disconnected from chassis).

The connection between L_2 and L_3 is made through a two-wire shielded cable about a foot long.

—*Art Miller, W9CPW*

—···—

Note on Decoupling Circuits

Circuit decoupling has caused many designers and builders of amplifiers considerable trouble. The author himself had not a little grief with one particular circuit, and as we know several others having had the same trouble, we feel a few words on the subject might be valuable. This is especially true as the circuit has appeared in most technical radio publications. To get down to cases, the guilty circuit is that shown in Fig. 22-A. The so-called "decoupling network," composed of R_d and C_d, is supposed to keep the grid bias constant over an audio cycle and, by this filtering out of the voltage appearing across R_k, prevent degeneration. To this end, the product R_dC_d is made large compared to the period of the lowest frequency to be passed, and as R_d may be made large, a fairly small capacity is supposed to suffice at C_d. We built an amplifier using this circuit, and were quite chagrined to find that there was no noticeable effect upon removing C_d completely! Then the light dawned. Although the network evidently keeps the point *Y* (Fig. 22) at cathode potential (for a.c.), to avoid degeneration we must *apply the signal* between the grid and a point at cathode potential—but here the signal is being applied between *X* and *Z*, and *Z* has the whole degenerative voltage developed across R_k between it and the cathode. (Anyone not satisfied with this proof can work out the circuit equation, which will be found to give the same result.) If the signal were applied between *X* and *Z*, everything would be fine, but to accomplish this, we must use transformer coupling (Fig. 22-B). However, if we wish to keep resistance coupling and cathode resistor bias we must by-pass R_k directly, as at Fig. 22-C. C_k should be large enough to keep the cathode at ground a.c. potential, for the signal is effectively being applied between grid and ground. In general, 5 to 25 μfd. is adequate for good low-frequency response in audio amplifiers. —*W9FTO*

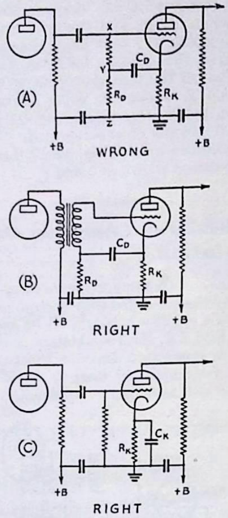


FIG. 22—THE WRONG AND RIGHT OF DECOUPLING CIRCUITS

—···—

The foil wrapper on Kodak films makes a fairly good diaphragm for a condenser mike when no diaphragm material is available. —*W5AUA*

'Phone Monitor Using 55

The circuit shown in Fig. 23 has been found to be very satisfactory for audio monitoring of an amateur 'phone transmitter. It utilizes a Type 55 duplex-diode-triode tube. The diode is used as a rectifier or detector and the triode as an audio amplifier. The diodes may be connected either for half- or full-wave rectification; the necessity for carrier frequency filtering can be eliminated by the use of full-wave rectification, the circuit being balanced so that the carrier frequency is not applied to the grid of the triode. When the diode is used as a half-wave rectifier (diode plates in parallel) the output will be approximately twice that of the full-wave rectifier, but theoretically carrier-frequency filtering will be required. Experiments carried out here indicate a decided increase in signal level when the half-wave rectifier is used, with no noticeable differences in other respects between the two systems. Methods of output coupling other than that shown may be used; for instance, an output transformer can be coupled to a 200- or 500-ohm line for remote monitoring, etc. The pickup coil is placed in inductive relation to the tank inductance of the modulated amplifier or the antenna inductance, the degree of coupling depending on the signal level desired.

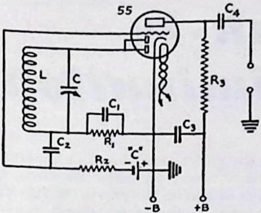


FIG. 23 — MODULATION MONITOR USING A TYPE 55 TUBE

C_1 — 250 μμfd.
C_2 — .01 μfd.
C_3 — .002 μfd.
C_4 — 1 μfd.
R_1 — .5 megohm.
R_2 — 2 megohms.
R_3 — .1 megohm.

A simple monitor of this type together with a dummy antenna will provide an adequate means of monitoring the modulation quality as well as indicating the character of the carrier. Hum, ripple and other extraneous noises due to improper filtering in the various r.f. and a.f. stages of the transmitter or other causes may be discerned readily and can be remedied without the usual interminable testing while the transmitter is on the air. The component parts of the monitor are shown below the diagram. The values of *C* and *L* will depend on the operating frequency. For the 75-meter 'phone band, 12 turns of No. 18 d.c.c. on a three-inch form, tuned by a 50 μμfd. condenser, have been found satisfactory.

— S. E. Newman, W3HN

Checking Hum or Modulation Quality

A monitoring arrangement which requires very few parts is shown in Fig. 24. It has been used for a considerable length of time with excellent results by Seiler Brothers, W8PK. A glance at the diagram will show that the system functions by picking up a small amount of audio voltage from the filament center-tap of the final amplifier and feeding it into a pair of headphones, utilizing an ordinary output transformer of the type used to feed a dynamic speaker for the purpose.

The diagram at A can be used with transmitters of moderate power, while that at B is recommended for high-power rigs. The resistance-condenser coupling will prevent burning out the transformer winding if the plate current of the stage exceeds 300 or 400 milliamperes. The transformer used should have good frequency response.

The signal level in the 'phones is high even with a low-power 'phone rig. This sensitivity makes the system useful for detecting hum in the signal, a feature which will make it appreciated by c.w. as well as 'phone operators.

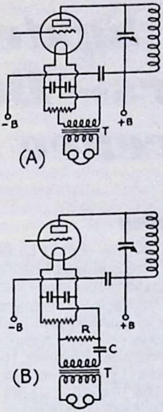


FIG. 24 — METHOD OF CHECKING CARRIER HUM OR MODULATION

T — Speaker output transformer, 10 or 15 ohms to tube plate. Low impedance winding connected in center tap; high-impedance winding to 'phones.
R — 10 to 15 ohms.
C — 2 μfd.

—···—

If your dynamic microphone sounds too "boomy," try putting a condenser in series with the voice coil and mike transformer primary. W9EQZ finds that a 1-μfd. condenser does a good job in his installation. The amount of capacity needed will depend upon the impedance of the microphone, of course, so it would be advisable to experiment a bit.

—···—

'Phone men who cause interference with neighbors' telephones might try placing a .002-μfd. fixed condenser across the mike button in the telephone, suggests W9TE. Such a condenser is already incorporated in the handsets. (Some telephone companies are rather prejudiced against unauthorized alterations in their circuits. — Ed.)

5

Keying Systems—Keying Monitors—Break-In—Interference Elimination

Blocked-Grid Keying

THIS keying system should be of interest to those who wish to use grid-leak bias on a medium- or high-power final amplifier stage and yet retain the advantages of keying in a low-power circuit. It is a combination of blocked-grid and center-tap keying that requires only one resistor to furnish the grid-blocking voltage. However, its development by the writer was to gain an entirely different end — to prevent the preceding amplifier from feeding through the final amplifier into the antenna, in an unshielded transmitter, by cutting down the power output of the preceding stage. The scheme shown in Fig. 1 was finally hit upon.

The transmitter in question consists of a 47 crystal oscillator, 46 buffer and 203-A final amplifier. Only enough of the apparatus to illustrate the point is shown in the diagram. A 40,000-ohm resistor, R_1, was inserted in series with the grid leak in the final stage, then the center-tap of the 46 stage was opened and the center-tap connected to the negative of the final stage. The negative of the 46 stage was connected to the grid end of the 40,000-ohm resistor. The key or relay is connected across the resistor. In this case a voltage drop of approximately 180 volts was secured across the resistor and the 46's plate current was reduced to about 4.5 mills. Therefore, we have 180 volts of bias on the grid of the 203-A and the power input to the 46 is reduced to about two watts with the key open. When the key is closed the circuits are normal with their negatives common.

Different setups will, of course, require different values for resistor R_1, and a variable resistor such as the Bradleyohm or its equivalent would be very convenient for adjusting to the proper value. Separate power supplies are necessary for the final and preceding amplifier stages. This system has been in use here only a short time but has proven very satisfactory so far.

— *Wm. B. Hann, W8GBC-INC*

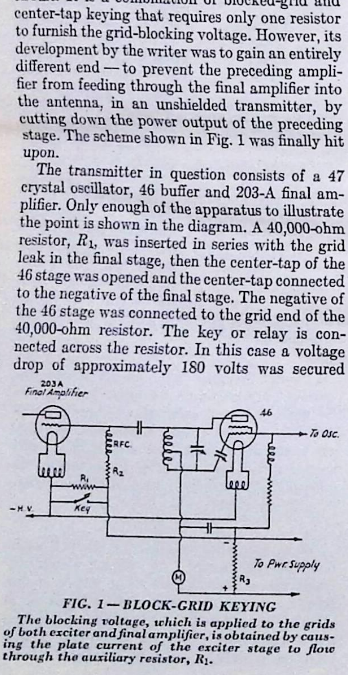


FIG. 1 — BLOCK-GRID KEYING

The blocking voltage, which is applied to the grids of both exciter and final amplifier, is obtained by causing the plate current of the exciter stage to flow through the auxiliary resistor, R_1.

* * *

Chirpless Keying With Pentodes

FELLOWS who have been having trouble with chirps in keying pentode crystal oscillators should find a kink contributed by Roy H. Raguse, W6FKZ, of value. W6FKZ says that his first attempt at keying a 47 oscillator brought plenty of chirps until he installed a voltage divider to supply voltage to the screen instead of using a simple dropping resistor. This required no

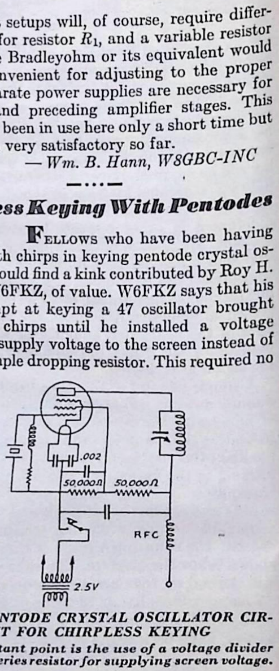


FIG. 2 — PENTODE CRYSTAL OSCILLATOR CIRCUIT FOR CHIRPLESS KEYING

The important point is the use of a voltage divider instead of a series resistor for supplying screen voltage.

change in the oscillator except the addition of a 50,000-ohm resistor between the screen and negative B, as shown in Fig. 2. With the screen voltage tied down the chirps disappeared.

The value of the extra resistance needed does not seem to be critical, a 20,000-ohm resistance having been installed by the editor in an oscillator similarly afflicted with chirps without changing the output from that obtained with the ordinary 50,000-ohm series resistor. The voltage divider also cured the chirp.

—···—

Keying the Link Circuit to Prevent Clicks

The keying arrangement shown in Fig. 3 is being used successfully by Bob Potter, VE3TO, to eliminate key clicks from an m.o.p.a.

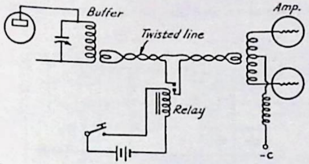


FIG. 3 — KEYED LINK BETWEEN DRIVER AND AMPLIFIER

transmitter with a pair of 10's in the final stage. The keying relay is simply inserted in the twisted-pair coupling line between the final stage and its exciter. The keying is as clean as with other systems, and its efficacy in preventing clicks is demonstrated by the fact that VE3TO's transmitter causes no interference in a b.c. receiver whose antenna is parallel to and only seven feet away from the transmitting antenna.

The final amplifier must, of course, be provided with fixed bias to cut off the plate current when the excitation circuit is open. VE3TO also says that it is necessary to neutralize the amplifier carefully, otherwise the signals are likely to have "tails."

RK-20 Keying Circuits

Two circuits for keying the suppressor of a transmitting pentode such as the RK-20, suggested by Herbert Hoover, Jr., W6ZH, are shown in Fig. 4. Both operate on much the same principle — that of cutting off plate current by means of negative bias on the suppressor grid — the first being for direct keying and the second keying through a small triode.

An auxiliary supply of about 400 volts, used both for control-grid and suppressor bias, is required. In circuit *A* with the key closed the suppressor is 45 volts positive with respect to the cathode, the positive voltage being obtained from a tap on the plate-supply bleeder. With the key open, however, the suppressor becomes 400 volts negative with respect to the cathode, the plate current being blocked off completely under these conditions. The 50,000-ohm resistor has no effect on the negative bias voltage, being in the circuit simply to limit the current flow through the key circuit when the key is closed.

In circuit *B* the positive suppressor potential is supplied through the plate-cathode circuit of a triode such as the 56. The cathode circuit of the 56 is completed through a 50,000-ohm resistor and the tap on the bias supply, the tap being adjusted to give plate-current cut-off on both the 56 and the RK-20 with the key open. When the key is closed, the grid potential of the 56 becomes positive, the plate resistance of the keyer tube drops to a low value and the voltage applied to the suppressor or the RK-20 is approximately 45 volts positive. The value of the resistance *R* in series with the key can be adjusted to give the necessary positive grid bias to the 56 under key-down conditions. It may not be needed at all, although some resistance at *R* will be helpful in preventing flow of grid current in the 56. The advantage of the tube-keying circuit is that the suppressor circuit is not interrupted by the key itself with the result that keying transients are reduced. The time-lag in the keying can be made almost any value desired by proper proportioning of resistors and condensers, since the keyed current is practically zero.

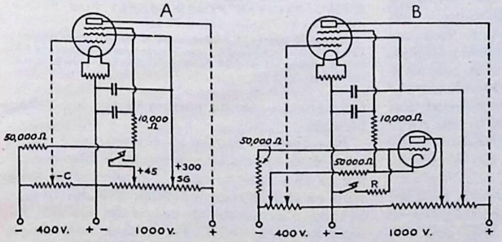


FIG. 4 — SUPPRESSOR-KEYING CIRCUITS FOR TRANSMITTING PENTODES

—···—

Grid Keying With Bias Supply

Using a four-stage transmitter, the bias problem is something to worry about, along with the usual ham trouble, key clicks and thumps. With a separate bias supply of about 400 volts, it is a simple matter to get cut-off bias for an 852 at 2000 volts. But using the common voltage divider caused the bias on the 852 to increase to as much as 425 volts under key-down conditions, when it should be around 180.

The scheme shown in Fig. 5 is self-explanatory. The two 10 stages are biased about the same as the 852 (190 volts). In the grid lead of each tube is a leak of the proper value, assuming resistor bias is being used. When the key is closed, it shorts out the fixed bias from the pack and falls back upon the resistor bias. The voltage divider used is 30,000 ohms, and shorting out about half of it throws no particular load on the bias supply.

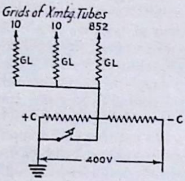


FIG. 5

This arrangement is used here to control three stages of my transmitter and it works FB. The key clicks are gone, and no thump filter is used on the bug. No hot key, no strong back-wave, and bias always on the tubes with the key open.

— *Theron Darrow, W8AZQ*

—···—

More Blocked-Grid Keying

If SEPARATE power supplies are used for the exciter and final amplifier stages, blocked-grid keying of the final can be accomplished quite easily without any auxiliary equipment except an inexpensive resistor and possibly a by-pass condenser. The idea is simply to use the exciter plate supply to furnish blocking bias for the amplifier.

An arrangement used by Peter Fakkema, W7AJ, with a two-stage transmitter consisting of a 59 Tri-tet oscillator and 10 amplifier, is shown in the upper diagram of Fig. 6. With the key open, the 300 volts from the oscillator supply is connected in series with the amplifier grid return to filament center-tap through the high resistance *R*. *R* is 100,000 ohms or more; its value is not critical, but it should be high. *R* acts in the combined capacity of a very high-resistance grid leak for the amplifier when the key is open and as a current-limiting resistor for the 300-volt supply when the key is closed. With the key closed, the amplifier grid bias is supplied solely by the regular grid leak. The filament by-pass condensers, *C*, should be capable of standing the oscillator plate-supply voltage.

A somewhat similar scheme has been used by the editor for some time with the general-purpose transmitter described in January 1935 *QST*. In this case the low-voltage supply for the oscillator and buffer tubes supplies both operating and blocking bias for the final stage. The lower circuit diagram of Fig. 6 shows the essential details. With the key open, the grids of the 801 amplifier tubes get the full 450 volts of the low-voltage supply through R_1, a 50,000-ohm 2-watt resistor. With the key closed, that part of the low-voltage bleeder between negative and the tap to which the key is connected serves as a combined grid leak and bias supply. A few slight changes are necessary in the circuit diagram given on page 17 of January 1935 *QST*. The grid leak, R_3, should be removed and a separate bias terminal brought out. For insulating purposes a fixed condenser should be connected in the common r.f. line between the final and exciter stages, as shown at C_1 in Fig. 6 herewith. In operation, the tap on the low-voltage bleeder should be set to cut off the amplifier plate current with excitation removed; when excitation is applied the bias will increase beyond cut-off because of the flow of grid current through the biasing portion of the low-voltage bleeder.

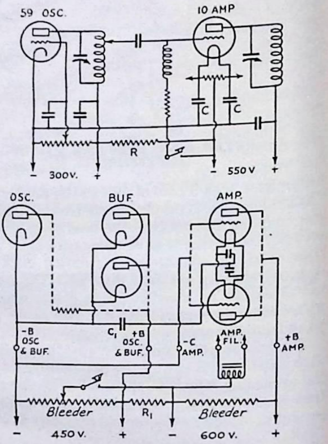


FIG. 6—BLOCKED-GRID KEYING SYSTEMS USING EXCITER PLATE SUPPLY FOR BLOCKING BIAS

R and R_1 are high resistances of the order of 50,000 to 250,000 ohms. C and C_1 are insulating condensers having a rating of about 1000 volts for low-power transmitters.

Key thumps can be eliminated quite readily with these keying arrangements. A filter consisting of two air-core chokes, connected in series with each key terminal, with a 1-μfd. by-pass condenser across the chokes on the line side, has been very successful. The chokes were simply windings from some old 30-kc. i.f. transformers, or some 80-mh. chokes of the type used in receivers.

Oscillator Keying With Grid Leak Bias On Amplifiers

It is well known that oscillator keying offers many advantages. But lack of a bias supply for the buffer and final grids had me stumped until I cooked up the scheme here presented. The only requisite (for two reasons) is a separate power supply for the oscillator stage. In the first place, the plate voltage of a keyed oscillator (even with e.c.) should have good regulation, which it will not have if a tap on a voltage divider across a high voltage supply is used. The other reason will be obvious after a glance at Fig. 7, which shows the essentials of the circuit.

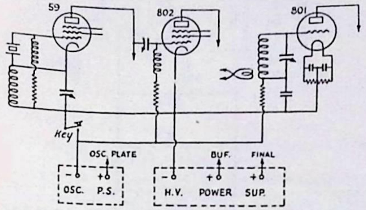


FIG. 7 — THIS CIRCUIT ELIMINATES THE NEED FOR FIXED BIAS ON AMPLIFIER STAGES FOLLOWING A KEYED OSCILLATOR

The blocking bias available is about 200 volts, which will take care of all low- and most medium-power tubes at normal plate voltages.

The negative terminals of the two power supplies must *not* be connected together. The cathodes and filament center taps of all stages are connected together and to one side of the key and negative of the high-voltage power supply. The d.c. grid return leads of the buffer and final are not connected directly to cathode and filament center tap, but are tied to the other side of the key at A and B and to the negative terminal of the oscillator pack. But don't move the grid leaks!

The system depends on the fact that when the key is open, a considerable voltage appears across it. (With 300 volts on my 59 Tri-tet, there are about 200 volts across the open key.) This voltage is used as negative bias on the amplifier grids to replace the grid-leak bias which exists when the key is closed. Incidentally, the key not only breaks the oscillator cathode current but also the grid current of the amplifier stages. But there seem to be no key clicks, and plate current to the buffer and final cuts off completely when the key is open.

— *L. V. Blake, W5FFZ, ex-W1IAT*

—···—

Crystal Oscillator Keying

Fig. 8 shows two crystal keying circuits which operate entirely on the r.f. portion of the circuit and break no d.c. contacts. That shown at A is used by Nat C. Smith, ex-W9UJ-W2CZU, who writes:

"This method eliminates the key clicks so that it is impossible to tell when the transmitter is keyed when listening to the receiver; no clicks, just a shushing sound, is the result.

"A relay is required. The contacts need not be very husky as no sparking is evident. The back contact of a s.p.d.t. relay is used.

"Pressing the key removes the ground from the crystal and the plate milliammeter will show normal current for the crystal in oscillation. When the key is released, the relay grounds the crystal and plate current rises about 25%. My oscillator with 375 volts on the plate has the following currents:

Crystal grounded — 40 ma.
Crystal oscillating — 25 ma.

"Naturally the stages following the crystal must be biased to practically cut off to prevent tube damage when excitation is removed."

A system operating on much the same principle is shown in Fig. 8-B. In this case a keyed loop coupled to the plate tank is used to detune the circuit and thus control oscillation. This arrangement is suggested by S. G. Read, W8JUQ. It has been his experience also that key clicks are completely absent on a receiver in the same room.

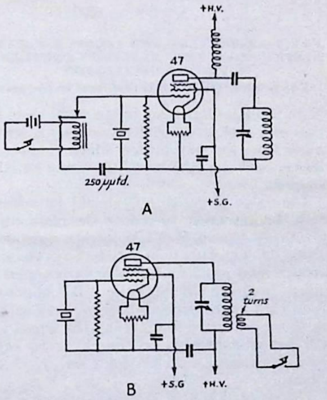


FIG. 8 — CLICKLESS CRYSTAL KEYING CIRCUITS

That at A operates by grounding the grid (for r.f.) with the key open. In B the plate circuit is detuned with the key open.

The keying loop need have only about two turns, closely coupled to the plate coil. To tune, close the key and adjust the plate tuning for oscillation, tuning far enough on the high-frequency side of resonance to give clean-cut keying. When the key is opened the circuit is detuned and oscillations cease.

Keying the E.C. or Tri-tet Oscillator

In an attempt to get clickless and chirpless keying of an electron-coupled oscillator, the circuit of Fig. 9 was worked out by H. C. Cooper, W4CUW. Trials of other systems, such as straight cathode keying, breaking the −B lead, and so on gave plenty of clicks, but these were eliminated by keying across a high-resistance cathode resistor as shown in the diagram.

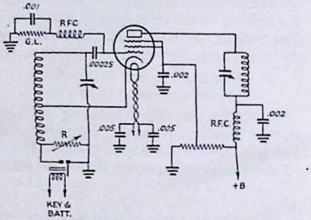


FIG. 9 — CLICKLESS AND CHIRPLESS KEYING SYSTEM FOR THE ELECTRON-COUPLED OR TRI-TET OSCILLATOR

The value of resistor R is discussed in the text.

With oscillator inputs up to ten watts there is no sign of a click in a b.c. receiver only a few feet away from the transmitter, which consists of a 59 e.c. oscillator (the keyed tube) and an RK-20 amplifier.

The value of resistor *R* should be adjusted, *with the key open*, to reduce the plate current practically to zero. W4CUW found a resistance of about 100,000 ohms to be satisfactory; the actual resistor used was an adjustable carbon-pile type taken from an old Majestic "B" eliminator. Somewhat more resistance was required with the oscillator converted to a Tri-tet; the actual value will depend somewhat on the particular crystal used, since some tend to "hang on" more than others.

The rig at W4CUW is keyed through a relay, as indicated in the diagram. The connections to the relay contacts should be short, since these contacts form part of the tuned circuit when closed. It should be possible, however, to connect a mica by-pass (about 0.001 μfd.) across *R* and use leads of any convenient length to the key. Should this be done, the relay may be omitted, the key itself being connected across *R*. There is no sparking at the contacts, and no thump filter is needed, at least up to the aforementioned 10 watts input.

—···—

Suppressor-Grid Keying

No doubt one of the simplest ways to achieve break-in operation with a multi-stage transmitter is to key the cathode circuit of the crystal oscillator and bias the following stages to cut-off. Many stations use this system and, while it does permit break-in operation, it often gives a somewhat chirpy note that isn't much of an improvement over a self-excited oscillator. Even if it doesn't chirp, the thumps and clicks are often difficult to eliminate.

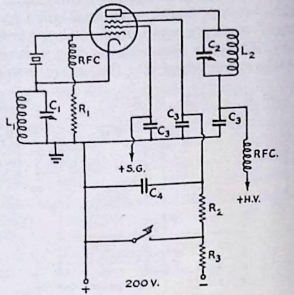


FIG. 10 — SUPPRESSOR KEYING OF A TRI-TET OSCILLATOR

C_1 — 150–250 μμfd. variable.
C_2 — 50–100 μμfd. variable.
C_3 — 0.005 μfd.
C_4 — see text.
R_1 — 50,000 ohms.
R_2 — see text.
R_3 — Bleeder resistor, 30,000–50,000 ohms, 2-watt.
L_1, L_2 — Suitable to tune to desired frequency.

One method of keying that will allow break-in operation right up to the frequency of the crystal is that shown in Fig. 10. A Tri-tet oscillator is used, with suppressor-grid keying as outlined previously.[1] Using a blocking voltage of 200 volts or so (which may be obtained from an old receiver power pack, or your present bias supply), perfect cut-off of output is obtained. There is the advantage that, since the crystal is running all of the time, there is no chirp with keying. The receiver will pick up the radiation from the cathode circuit of the oscillator, but ordinarily this will be no stronger than an S8 or S9 signal, when the transmitter is in the same room as the receiver. By shielding the oscillator this signal will be greatly reduced.

R_2 and C_4 constitute a lag circuit that eliminates any thumps. The resistor and condenser can have practically any value, so long as their product (ohms times micro-farads) is around 5000. It is not wise to have the value of resistance too high, especially if the suppressor-grid has a positive voltage impressed on it when the key is down, as shown in the article referred to; 5000 or 10,000 ohms is about right.

This circuit has been tried using an RK-25 and also an 89. Both gave clean keying with the output circuit tuned to either the crystal or to the second harmonic.

—*W1JPE, ex-W6CAL*

---

[1] Grammer, A Medium Powered Transmitter for 7, 14, and 28 Mc. *QST*, October, 1936, page 17.

A Different Keying-Tube Circuit

The circuit shown in Fig. 11 was devised by the writer for W4BAT, who uses a single 10 Hartley drawing 60 mils at 550 volts. I believe it is about the ultimate in simplicity and effectiveness. The tube drop is nearly negligible when a single 45 of normal characteristics is used to key the load mentioned. The cut-off is complete even though it would not appear so at first glance at the circuit. Actually the current is so low as to be scarcely perceptible on the milliammeter. The tube drop is very low because the grid is tied to the plate when the key is down, and there is no interfering (bias producing) resistor in the grid circuit when the key is pressed. The resistor R is nothing more than three solid carbon 75,000-ohm resistors in series which gives more than the necessary dissipation. There is no objection to tying the grid and plate together as under the conditions which exist the grid current is not dangerous to the grid structure. It is only when the grid is more positive than the plate that a damaging grid current would flow and this is not the condition in the circuit shown. Since W4BAT already had an extra 2½-volt winding on the power transformer, the cost at net prices was less than $1.00.

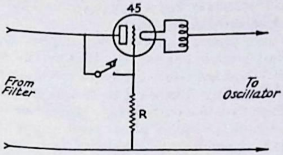


FIG. 11 — A VACUUM-TUBE KEYING CIRCUIT FOR ELIMINATING CLICKS

The resistor R may have any value which makes the current drain through it small when the key is closed. For a 500-volt plate supply W4IS used 225,000 ohms with success.

The key breaks the current which flows through the resistor, and since this current is of the order of a mil or so and is in shunt with the power supply, not in series with the load, any spark has negligible effect on the output of the oscillator. As a matter of fact the spark produced was not perceptible in daylight and was of no noticeable effect. A single 45 will suffice to key a load of 60 mils or more with small voltage loss. Without changing any constants two or more 45's or other types could be paralleled to key heavier loads. The keyer tube obviously will run cool as its internal resistance is made very low when the grid and plate are tied together. It is obvious also that the tube has less internal resistance than a rectifier or two-element tube of similar construction, as a result of the fact that the grid neutralizes the space charge with some degree of completeness when it is tied to the plate.

Of course the simple circuit shown can be applied to loads of greater current and voltage by using different constants. In any case the resistor R should be high and of sufficient size to dissipate the necessary heat. The formula $W = E^2/R$ will give the watts to be dissipated by the resistor when E is the voltage of the power pack and R is the resistance in ohms.

— *J. D. Blitch, W4IS*

* * *

Improved Keying-Tube Circuit

The circuit of Fig. 12, utilizing keying tubes with a fixed-bias supply for blocking, is suggested by J. O. Sales, W6HFF. He writes:

"An examination of the circuit will show that the internal resistance of the keying tube is in series with the center-tap return. This resistance is high with the key open, thereby giving very high bias and low-effective plate voltage on the tube being keyed. The bias on the keying tube need not be as great as in usual tube keying systems; the effective bias on the two tubes in series in the high voltage circuit blocks the plate current. The operation of the system is more positive than either grid-block or tube keying alone, and the current broken by the key is less. A slightly lower value of grid bias or leak than usual should be used because the plate resistance of the keying tube at zero bias is in series with the c.t. return (cathode bias) with the key down. This system works excellently with the crystal oscillator and allows break-in operation without any click in your own receiver."

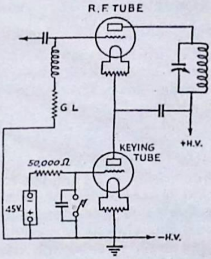


FIG. 12 — TUBE KEYING CIRCUIT

Values are for a Type 45 tube, to handle an r.f. tube comparable to the 10.

* * *

Eliminating the Keying Relay Battery

In casting about for some cheap means of eliminating the one remaining battery in the shack — i.e., the 6-volt hot-shot to deliver 40 mils or so to the 150-ohm keying relay — the writer hit upon the simple but effective stunt shown in Fig. 13. The idea is to make the bleeder current (in this case that of the power pack supplying a 47 crystal oscillator and 46 buffer) do something more toward the general cause besides generating BTU's in the resistor. With the key up, the bleeder resistance is 13,000 ohms, drawing 23 ma. With the key down, the resistance is 12,130 ohms, and, contrary to expectations, the current is within ¼ mil of 23 ma., since, although the resistance is lowered, the keyed load goes on the pack and pulls the voltage down to around 275 v.

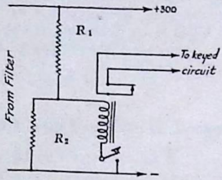


FIG. 13 — POWER SUPPLY FOR THE KEYING RELAY FROM THE LOW-VOLTAGE POWER PACK

R_1 is the regular bleeder resistor, 12,000 to 15,000 ohms. R_2 is 1000 ohms, 1-watt size. The keying relay is a 150-ohm telegraph relay. Any relay capable of working on 15 to 20 ma. d. c. can be used successfully.

The relation between R_2 and the resistance of the relay coil of course determines the amount of current flowing in the latter, and with the values shown this current is ample to actuate the relay (an ordinary telegraph relay is used here) at high "bug" speeds. The generally accepted current value for a 150-ohm instrument of this type is 40 mils, but the writer finds that this can be reduced to 20 mils and still give enough "range" for an application of this sort. The value of R_2 is not at all critical within a few hundred ohms. As low as 300 ohms will still allow enough current to flow through the relay to energize the windings, but the operation becomes feeble and the dots "light." The maximum power to be handled by R_2 (1,000 ohms) is 0.5 watt with key up — with key down it is negligible — and a 1-watt resistor is ample.

— *Arnold W. Lewis, VE4IY*

Keying-Relay Circuit Clicks

Another note on the old problem of clicks is sounded in the following dope from A. J. Thompkins, W6FBE:

"Am running a 650-watt c.w. job, crystal-controlled, on 7280 kc. in a full apartment building. As the rig is in a Westinghouse cabinet, the possibilities of slipping it into the building unnoticed were about as remote as bringing in a refrigerator under my vest. As a result I was blamed for all the radio interference in the place. That was not strange since I was causing a lot of it, especially in one museum piece.

"The problem was one of either changing my keying system or making it noiseless. This rig is keyed in the primary of the plate transformer which supplies the two final stages. By-passing the 110-volt line strangely did not end the difficulty, though it did stop blanketing. Tests showed that the arc at the key which in turn actuated the relay was causing the grief.

"A good friend who knows his engineering better than I made the remark that in the keying circuit I had introduced a lot of inductance, the coil of the relay. The good book tells us that this condition causes a current lag. Also if the voltage and current are out of phase there is more spark on the make and break of the key than if we have unity power factor. 'Well,' says the friend, 'put some capacity across the coil of your relay and balance up the circuit.' He suggested placing an a.c. milliammeter in the key-to-relay circuit and substituting condensers until a minimum reading was attained, which would indicate unity power factor. However, not having the prescribed meter, I took a chance on putting a mike of capacity across the coil. That must have been about what the doctor ordered, as the spark is cut to nearly no spark at all and now it is possible for me to run my broadcast receiver without interruption, and it is only about three feet from the transmitter and key.

"It may be argued that the trouble was coming from the arc on the relay but that was not the case as the interference was experienced when the relay was operated whether the transmitter was running or cold."

A Clickless Keying System

In trying to eliminate key clicks entirely from the receivers of neighboring hams who were working on the same band, as well as to keep peace with the BCL's, I worked out a keying system which has undoubtedly been used before, but which deserves more general acceptance.

The scheme consists of keying the primary of a small B-eliminator power transformer, the rectified and filtered output of which furnishes the positive voltage for the shield and suppressor of the 59 doubler tube, as shown in Fig. 14. To make cut-off complete, a negative voltage from the regular bias supply is furnished to the two grids through a resistor. Since the primary of the transformer is keyed, it is necessary to supply the filament of the rectifier tube from a separate source.

Thus, when the key is open, the grids are made sufficiently negative to give cut-off — in my case about — 40 volts, while the control grid was being excited, and with 550 volts on the plate. When the key is closed, the grids go positive by an amount determined by the size of the transformer and the desired operating voltage. The filter on this supply should be not larger than necessary, since too much filter introduces lag.

The advantages of this system are: (1) Better keying due to the elimination of keying relays, since the small current in the primary of the transformer can be broken directly by the key; (2) less BCL QRM because the noise caused by breaking the small transformer primary is much more readily filtered out than the racket caused by breaking half a kilowatt.

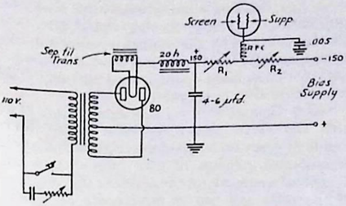


FIG. 14 — CLICKLESS KEYING SYSTEM FOR PENTODES R_1, R_2 ARE 0–1000 AND 0–5000 OHM VARIABLE RESISTORS, RESPECTIVELY

— *W. N. Lambert, W9TBX, ex-9CSC*

—···—

Key-Thump Kinks

The diagram of Fig. 15, showing the arrangement used to eliminate key clicks and thumps at W1AUN, is submitted in the hope that it may be of help to other amateurs who are bothered by the same trouble. It has taken a long period of experimenting here with all sorts of arrangements to find that the trouble was being caused by the high-frequency surges getting into the *110-volt supply line,* and being *wired* to most of the neighboring BCL sets, causing anything from an ordinary click to complete blocking of the receivers.

In common with the average operator, I was very much against any arrangement which would decrease the power of my transmitter, but the circuit shown in Fig. 15 had not the slightest noticeable effect on the efficiency.

The parts were obtained from an old "B" eliminator, except for the condenser and resistance across the key. C_1 and C_2 are simply the condenser block from the eliminator, and L_1 and L_2 are the chokes. The 110-volt line to the power transformers should be run in BX cable with the metal covering grounded.

One thing seems to be very important in regard to the key connections. The wires from the key to L_1 and L_2 *must* be as short as possible. Wires only a foot long will radiate enough energy to be heard in a neighboring BCL set. Shielded cable with the shield grounded may be of help although I have not tried it. However, by locating the chokes directly at the key, and with the parts arranged as in the diagram, no interference is caused in a nine-tube superheterodyne located in the same house and having its aerial connected to the same pole as my transmitting antenna.

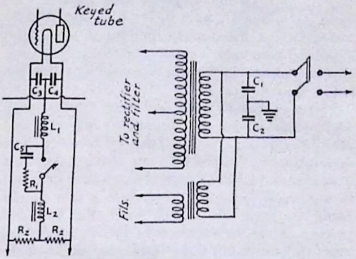


FIG. 15 — KEY-CLICK ELIMINATOR

C_1, C_2 — Filter condensers from "B" eliminator (p.5 μfd. or more each should be sufficient).
C_3, C_4 — Oscillator filament by-pass condensers (.002 or larger).
C_5 — 1 μfd.
R_1 — 10,000 ohms.
R_2 — Center-tap resistor.
L_1, L_2 — Chokes from "B" eliminator.

— *Gordon Wiley, W1AUN*

—···—

A Cure for Blanketing

BCL trouble among about twenty-four b.c. receivers located in the same apartment building with my transmitter had refused to respond to traps, "broom-handle" chokes, filters, new antennas or changes in the operating frequency. This condition had caused self-imposed quiet hours for about two years. Key clicks and thumps were eliminated by conventional methods but blanketing remained very serious, especially in an old t.r.f. relic. The finally-discovered cure — and an absolute cure at that — was the insertion of one "pie" of a National R100 choke right at the antenna post of the BCL receiver. The cure was so complete that the owner of the aforementioned set, whose antenna is about ten feet from mine, does not know when this station is on the air, either with 'phone or c.w.

A word of instruction: Insert all four pies of the choke first, and tune the receiver to the highest-frequency b.c. station audible at the time. Cut out pies as necessary until the b.c. station maximum volume is slightly attenuated — not more than 25% by ear. One pie does the trick on most jobs, but in the case of an indoor antenna it is sometimes necessary to pull a few turns off even one pie. Save the other three pies — they are OK for the same purpose when mounted on a burned-out resistor.

— *J. Stanley Brown, W3EHE*

Washing Out the B.C. Interference

The following note from C. W. Roth, ex-W9DOU, may prove of value in cases where keying interference is caused in nearby broadcast receivers — especially when investigation shows that the trouble is caused by overloading of the receiver:

"Here at W9DOU we had some trouble with slight clicks in our own broadcast receiver, and complete blocking of a neighbor's receiver. The description of the effect on our own set was that it was 'clicking,' but a careful check revealed that it was very slight blocking, fading the signals being received on the set when the key was pressed. Someone's seemingly foolish suggestion was followed, and a radio-frequency choke of the receiver type was connected in the antenna lead of the b.c. set, with the result that nothing was received. Next, a choke consisting of No. 26 enamel wound solid for about 3 inches on a piece of broomstick was tried, connected as shown in Fig. 16, and the difficulty was cured. This was on 80 meters.

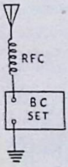


FIG. 16 — CHOKE IN SERIES WITH RECEIVING ANTENNA TO REDUCE INTERFERENCE TO B.C. RECEIVERS

"Finally the neighbors got tired of having holes chopped in their programs so they spoke up, and investigation showed that the 160-meter transmitter was causing their trouble. Accordingly a choke was again wound on a broomstick with No. 26 enamel, but between four and five inches long; it was tried close to the receiver in the antenna lead and everything was jake.

"No investigation has been made to determine whether or not the length of the choke is critical, but it apparently is not, for other hams having this same trouble, identified as 'clicks,' have cured it by winding chokes of the approximate dimensions given, with no case of failure to date."

—•••—

Parasitics and Interference

Here's a new angle on the ever-present key-click problem: the relation between key clicks (and 'phone interference as well) and parasitic oscillations. The following dope from B. P. Hansen, W9KNZ, tells the story:

"The new transmitter here has a pair of W.E. 242-A's in push-pull in the final, running up around 750 watts on c.w. and about 400 input on 'phone. Keying is accomplished by a d.p.s.t. Dunco a.c. relay. One pair of contacts closes the oscillator center tap. A split second later, the other one closes all high-voltage primaries. Thus the make click is taken care of by straight primary keying, since the primaries are closed with full load. On the break, the primary contacts break first, making elimination of this click easy also. Straight primary keying would give tails, but this is licked by the oscillator center-tap contacts opening a fraction of a second after the primary contacts have opened, thus cutting off the tails before they get a start.

"Now then, I've used this same relay, along with the same customary click filters, for a couple of years on a half-dozen rigs, including the bread-board version of the present one, and never had a squawk on clicks unless the margining of the relay got out of whack due to contact wear. This could always be corrected by remargining the relay. But when I put this new rig into its steel cabinet and built the parts up on metal chassis, there were the clicks. There was also a nice batch of 'phone QRM to the BCL sets around the neighborhood. Bias to the final is obtained through a 10,000-ohm grid leak only — no fixed bias. One day, was re-neutralizing the thing after having made some changes and happened to put the plate voltage on the final with no excitation on it. The darn thing went right to town, oscillating merrily although the neutralization was perfect. Parasitics, of course. Slapped on a little fixed bias just to see, and sure enough, it took just a little fixed bias to make the final as stable as a rock. Well, a choke made of four turns of hookup wire, wound around a pencil and stuck in the socket grid lead, ahead of neutralizing condensers and everything else, cured that trouble completely. But, to my great surprise, it also cured the key-click trouble, every trace of it. And a hurried test on 'phone showed a remarkable improvement there. Many of the neighborhood cases simply cleared themselves, although of course there are still a few antiques that have some QRM. But, whereas wave traps had no effect before, they now effectively cleaned up the last trace of trouble.

"As it looks to me, it took a split second for the oscillator to start when the key closed. During the interval, there was no bias on the final because there was no excitation and the parasitic had a good chance to get going and put in a few dirty licks. Then, the oscillator got under way, excitation came through, bias resulted, and the thing may or may not have stopped. Probably didn't, because there was always trouble when I modulated. That parasitic may have had a half dozen or more different frequency components — it certainly had a honey in the five-meter band. This could give the effect of a transient resulting from the more common causes of clicks. I'm satisfied that it did.

"Then the hash from the 866's. After I got the clicks cleaned up I called W9KI who lives exactly across the alley from me. He gave me a clean slate on the clicks and the 'phone QRM but said there was some hash at several spots where he picked up my sigs. I closed the steel door of the cabinet that houses the transmitter and practically wiped that out. Also wiped out the harmonics from S7 to 8 to a mere trace of a signal. So it does seem that a completely enclosed, shielded rig has its merits, if only from the standpoint of local QRM."

—···—

Neon-Bulb Audio Oscillators

HERE is a neon bulb audio oscillator for monitoring keying and for code practice which can be assembled for less than $1.00. But let no mistaken ideas develop as a result of this neon oscillator being called a keying monitor. *It does not monitor the transmitted signal.* It has nothing to do with the frequency drift or shift or character (if any) of the emitted wave-form, such as it may be. Therefore, it does not replace the regular station monitor.

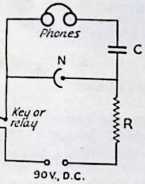


FIG. 17 — THE OSCILLATOR USED AT W9UZ
N — Westinghouse N-1 neon bulb.
C — 0.002 μfd.
R — 1.5 megohm.
Supply, 90 to 110 volts, d.c.

For monitoring keying during transmission the oscillator ought to be connected to the keying system in such a way that it may be used without putting the transmitter on the air. The output of the audio oscillator is supplied directly to the headphones or loud speaker, providing a means of continuously observing the manipulation of the key or bug, or whatever else it is that some amateurs use to splash out what is alleged to be International Morse. Since the oscillator can be keyed without cranking up the transmitter for code practice, by its use idle "air practice" may be reduced considerably.

The keying monitor in use at W9UZ is represented by the circuit shown in Fig. 17. The monitor is keyed with a small relay which is connected in parallel with the regular transmitter relay so that both can be keyed without putting the transmitter on the air. A changeover switch is used to switch the headphones from the receiver to the monitor. The neon bulb is a Westinghouse N-1, although any small neon bulb will oscillate. Several different types were tried. The applied voltage must be direct current, either from the receiver power supply or from batteries. If batteries are used, they may be the smallest size because the current flow is less than 100 microamperes (1/10th of a milliampere) and the batteries will last many, many months.

The mounting base is a piece of bakelite, 1/16th of an inch thick, 2½ inches wide and 4½ inches long. A grid-leak type of holder supports the resistor and makes possible a quick change when another audio frequency is to be used.

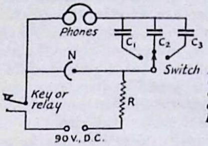


FIG. 18 — A THREE-FREQUENCY CIRCUIT
N — Neon bulb.
C1 — 0.001 μfd.
C2 — 0.002 μfd.
C3 — 0.003 μfd.
R — 1.0 megohm.

There may be some variation in characteristics of the neon bulbs; therefore, each oscillator should be adjusted to the desired frequency accordingly. Changing bulbs may cause the frequency to shift as much as 200 cycles per second. Varying the voltage by means of a potentiometer, or some other method which will permit small voltage changes, gives corresponding changes in the frequency of the note. An increase in voltage will increase the frequency, while reducing the amount of resistance or of capacitance also increases the frequency — and vice-versa. Normally, the neon bulbs break down (that is, they commence to glow) at about 100 to 115 volts. Relatively, this is unimportant because if some particular bulb does require as much as 105 volts, the desired frequency can be obtained by selection of the proper values of the condenser and resistor. Some bulbs will start to oscillate with 75 or 80 volts. It isn't necessary that the orange glow of the bulb be as bright as an airport beacon — the output does not increase materially with increase in brilliance of the glow. The Westinghouse N-1 neon bulb may be identified by the two spiral conductors inside the glass envelope. It fits the standard candelabra socket.

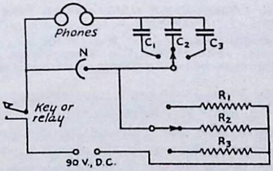


FIG. 19 — THIS ONE GIVES A WIDE RANGE OF TONES

N — Neon bulb.
C1 — 0.001 μfd.
C2 — 0.002 μfd.
C3 — 0.003 μfd.
R1 — 0.5 megohm.
R2 — 1.0 megohm.
R3 — 2.0 megohms.
E — 90 to 110 volts, d.c.

Numerous combinations are possible, giving circuits which are very flexible. The circuit of Fig. 18 provides three frequencies, three condensers of different values being connected together at one terminal while their other terminals are connected to a three-point switch. By switching from one condenser to another, different notes are selected. Another possible combination would be to arrange several condensers which could be connected in parallel by means of a switch. The circuit of Fig. 19 represents a selection of a greater number of frequencies, since each combination of condenser and resistor will generate a different frequency. To this, add a means of voltage variation, and every reasonable audible frequency is at the command of the operator. This is one of the most satisfactory devices for code practice—which, taken occasionally, doesn't do any harm at all.

—···—

Neon-Bulb Oscillator for Tone Modulator

THE above article, covering the use of neon-tube audio oscillator as a keying monitor or code practice device, suggested another use for this simple and inexpensive equipment, to wit: tone modulator for i.c.w. on the 56-megacycle rig.

The writer, being an old-timer recently returned to amateur fold via the ultra-high frequency route, rather tires of 'phone at times, and has a hankering to oil up the old bug and have some QSO's in code. He debated between buzzer tone and a triode oscillator, until Mr. Schnell's timely suggestion came forth. The neon tube settled the question.

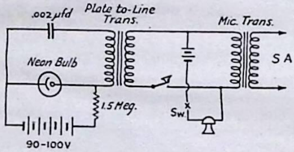


FIG. 20—NEON-BULB OSCILLATOR FOR TONE MODULATION OF THE 56-MC. TRANSMITTER

Condenser C and resistor R are 0.002 μfd., and 1.5 megohms, respectively. The microphone switch should be open when the tone modulation is used.

A few minor changes in the circuit were made as shown in Fig. 20 and the old-timer was on the air, with FB reports from all parties contacted.

Keying the output instead of the battery circuit resulted in a more constant frequency.

— *Ralph E. Henry, W6MXC*

—···—

Relayless Monitoring

MANY keying monitors and oscillators have been described in these pages, but never one which has satisfied the needs of this station, as well as others who are operating under the same conditions.

We wanted a system requiring no batteries or relays, to go with the 59 Tri-tet exciter unit, keyed in the oscillator negative lead, in use here. The circuit finally used is shown in Fig. 21. Most of the apparatus can be fished out of the old junk box.

It makes a difference which way the leads to the audio transformer are connected. If it fails to oscillate the first time reverse the leads on one side. Be sure to get the negative lead to the audio oscillator on the proper side of the key or bug in order to make and break the contact to the oscillator.

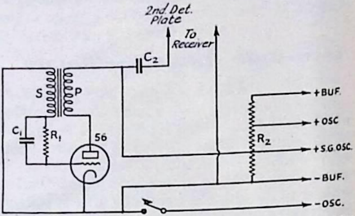


FIG. 21—KEYING MONITOR, USING AN AUDIO OSCILLATOR, WHICH REQUIRES NO RELAYS FOR SIMULTANEOUS KEYING OF AUDIO OSCILLATOR AND TRANSMITTER

C_1—*250 μμfd.*
C_2—*0.003 μfd.*
R_1—*1-3 megohms.*
R_2—*Crystal oscillator voltage divider.*

As shown in the diagram, the audio oscillator gets its plate voltage from the screen grid tap on the exciter voltage divider, the negative lead on both audio oscillator and crystal oscillator being keyed simultaneously. Incidentally the rig works well on voltages down to ten volts.

The signal from the keying oscillator is fed to the 'phones on the plate side of the second detector and keying can be monitored right up to your own frequency. A change in the note to suit the operator's fancy can be obtained by using various values of grid leak, although we found around one or two megs the best.

— *D. C. Strawn, W6AXN*

—···—

Monitoring Audio Oscillator With Keyer Tubes

FIG. 22 shows a keying system which needs no relays but will key both the transmitter and a monitoring oscillator. An audio oscillator and a set of keyer tubes with their filament transformer are all that are necessary. As shown in the diagram, the audio oscillator is used as a grid leak for the keyer tubes, the output of the oscillator being fed through C_1 to the headphones or speaker used for reception. A standby switch may be necessary if the receiver clicks badly. At the other end of the circuit the keyer tubes are connected in parallel. The key is connected to the grids and to one side of the filaments. A center-tapped resistor is not necessary. A by-pass condenser or r.f. choke should be inserted in the keying line to keep r.f. out of the keyer tubes and the oscillator. The plates of the keyer tubes go to the cathode of the stage to be keyed and the grids go to ground (B negative). If the crystal oscillator is keyed, break-in operation is possible and the system is very smooth, since one pair of 'phones handles both receiving and monitoring.

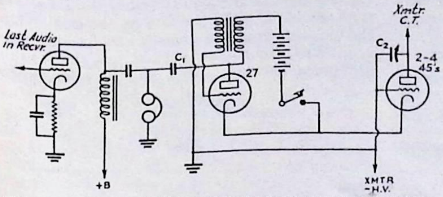


FIG. 22 — AUDIO OSCILLATOR FOR KEYING MONITORING COMBINED WITH TUBE KEYING

C_1 — 0.0025 to 0.05 μfd., mica.
C_2 — 0.002 to 0.06 μfd., mica.

— Jack Allen, W7ELG

— · · · —

"B" Power for the Keying Oscillator

A simple method of supplying plate voltage for an audio keying oscillator — and incidentally keying the oscillator as well — is shown in Fig. 23. It is a suggestion of J. C. Nelson, W8FU, who is using it with a single 46 in the final stage.

The resistor *R* is a variable having a value of about 400 ohms. It is simply adjusted to give sufficient plate voltage for the audio oscillator. Since the resistor acts as a cathode biasing resistor, it is desirable that the voltage drop across it be kept as low as possible. Since the audio oscillator should not require more than 20 or 30 volts, the drop in plate voltage can be considered negligible.

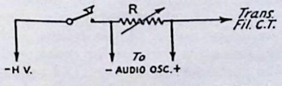


FIG. 23 — A CIRCUIT FOR OBTAINING PLATE VOLTAGE FOR AN AUDIO KEYING OSCILLATOR

Besides eliminating the necessity for a plate supply for the oscillator, this system requires no keying relays.

One advantage of the system is that no keying relays are required to take care of the audio oscillator.

Break-in Plus Monitored Keying

The idea contributed by W8FU suggests the further possibility of a complete break-in system without any relays or other moving parts.

The circuit is shown in Fig. 24. The receiver and transmitter negative terminals are grounded at a common point. When the key is pressed three operations occur simultaneously: The receiver output is grounded; the transmitter is put into operation, and the audio oscillator puts a signal into the 'phones.

When the key is released the transmitter and audio oscillator cease to work, and the receiver output is connected to the 'phones.

Several precautions should be observed. The leads carrying audio frequencies should be kept short. The key should have as little capacity as possible, otherwise the received signal may be by-passed to ground through this capacity when the key is open. A navy type key, i.e., without a metal base, is satisfactory. The two wires going to the key should be placed several inches apart and kept short.

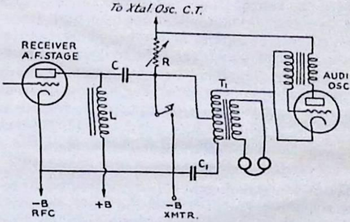


FIG. 24 — COMBINED MONITORING AND BREAK-IN SYSTEM WITHOUT RELAYS

L — 30-henry choke.
C — 0.5-μfd.
C_1 — 0.5-μfd.
R — 400-ohm variable resistor.
T — Audio transformer.
T_1 — Push-pull output transformer.

For break-in operation the crystal oscillator should be keyed. Since the oscillator takes a small current, sparking will be negligible.

The idea is presented for what it is worth, because the writer has been unable to get the equipment to see if it is practicable.

— Richard Libertucci

— · · · —

Simple Keying Oscillator

The audio oscillator described here is the height of simplicity and has been in use at W2DBQ for a number of years. It makes use of a dynatron audio oscillator which is keyed simultaneously with the transmitter. No relays are used. Power is supplied from taps on the receiver "B" supply. A small bakelite panel on the operating table holds the double-pole double-throw switch for the 'phones.

The only pitfall to watch out for is to be sure that negative sides of both the "B" supply and the transmitter power supply are on the same side of the key. If they are put on opposite sides, the dynatron oscillator will act as a high resistance in the center tap of the keyed transmitter stage, and will permit the tube to draw low plate current. It will be seen that this system can only be installed where center tap keying is utilized; no experiments have been conducted in regard to using it with grid block or other keying systems.

— *Richard E. Nebel, W2DBQ*

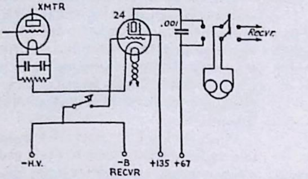


FIG. 25 — A DYNATRON AUDIO OSCILLATOR FOR MONITORING KEYING

The audio tone obtained will vary with different types of headsets and with the capacity of the fixed condenser in the plate circuit. It should be possible to change the tone over a fair range with a given headset by varying the capacity.

—...—

The newer screen-grid tubes are treated to reduce secondary emission from the plate, essential to dynatron operation. An old tube from the junk box may do a better job than a new one. — Ed.

—...—

Break-in and Monitoring System

A combined break-in and monitoring system which has given good results for about eight months on c.w., and which is now being applied to 'phone work at this station, is shown in Fig. 26.

Two relays are used, one taken from an old "B" eliminator unit, and the other being an a.c. telephone relay. If the system is to be used for c.w. alone, the contacts shown for the mike battery can be connected to the oscillator keying circuit, and the winding of Relay 1 connected to 3 volts d.c. When used for 'phone, the connections are as shown in the diagram.

In the transmitter there is a small Dunco 2.5-volt a.c. relay, with contacts in series with the high-voltage transformer. If the key is left closed, manipulating the a.c. relay in the transmitter will cause the relay system shown to operate automatically. Of course if a type of microphone requiring no current is used, the contacts shown for the mike battery circuit will not be needed except as mentioned above.

The system operates as follows:

When current passes through Relay 1, it closes the contacts to the grid circuit of the 112A, and puts about 50 volts positive on the grid. When the contacts are open, there is −22.5 volts on the grid. With the contacts closed, and the positive difference between −22.5 and 50 volts on the grid, the 4-μfd. condenser holds the charge, which leaks off at a rate governed by the 50,000-ohm potentiometer. The delay can be adjusted from 0 to about 1½ minutes, depending upon the adjustments of the relays, which, by the way, are quite critical for quick operation. Next, the plate current of the 112A operates the plate circuit relay, the contact arm of which is connected to one side of the 'phones. The other side of the 'phones is grounded. When the relays are open, the arm of Relay 2 rests on the receiver output side. When closed the arm rests on the monitor side, and will stay there after Relay 1 has been opened, depending upon the setting of the grid potentiometer. All voltages, except for the filaments, are supplied by the receiver, and the output of the receiver and monitor are resistance coupled against ground. Of course any type of coupling from receiver and monitor could be used so long as there is a common return for the 'phones, otherwise a d.p.d.t. relay would be required in the plate circuit of the 112A.

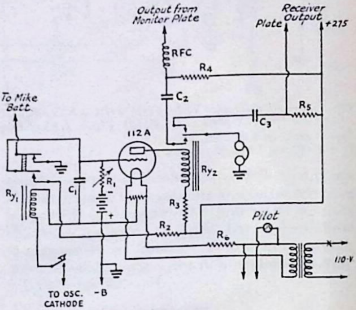


FIG. 26 — CIRCUIT FOR AUTOMATIC MONITORING WITH BREAK-IN

C_1 — 4-μfd. paper (not electrolytic) condenser, 300-volt rating.
C_2, C_3 — 0.1 μfd.
R_1 — 50,000-ohm potentiometer.
R_2 — 100,000 ohms.
R_3, R_4, R_5 — 25,000 ohms.
R_6 — 4 ohms.
Ry_1 — D.p.d.t. relay taken from "B" eliminator control unit, rewound to 75 ohms.
Ry_2 — Telephone relay, s.p.d.t., 100-volt, 20-cycle. The relay used has a d.c. resistance of 1000 ohms.

One can work virtual duplex with this system on 'phone by using the key and leaving the high voltage on. All that is necessary is to depress the key while speaking, and let it up when not speaking, the grid potentiometer being adjusted so that the 'phones will come back to the receiver, immediately the key is opened. Regardless of the switching method used, the system enables one to listen to what is being transmitted, whether c.w. or 'phone.

The only difficulty experienced at all was in adjusting the relays for operating at such low currents — 15 to 20 ma. oscillator plate current through Relay 1 and 6 to 10 ma. 112A plate current through Relay 2. All resistors, with the exception of the 112A filament resistor and the 50,000-ohm potentiometer, are of the 1-watt type, and all condensers shown are rated at 600 volts (working) d.c. The output tube of the receiver is a 56 and the monitor a 76. The plate resistors should be changed to suit any other type tube used.

— *J. P. Neil, VE3PN*

—···—

Continuous Monitoring With the Regenerative S.S. Super

A METHOD of monitoring transmissions which requires no switching, relays, or in fact any extra apparatus except the receiver and the regular heterodyne frequency meter has been devised by J. Stanley Brown, W3EHE. The transmitter is heard whenever the key is touched, the operation of the receiver being unaffected in any way. W3EHE writes as follows:

"Some good schemes of continuous monitoring have come out, but it is seldom that they made use of only essential apparatus and did not require a lot of relays, additional click filters, etc. A method of accomplishing the desired result is in use here and working OK within a few feet of a transmitter with 100 to 125 watts keyed input.

"The receiver used is a variation of James Lamb's regenerative single-signal job with an r.f. stage added. Except for a separate single wire receiving antenna, at right angles to the regular transmitting Zepp, the only other piece of equipment used is the station freqmeter. A front-of-panel pin jack is connected to the cathode end of the r.f. regeneration control resistor, and a 'phone cord connects this jack to the output jack on the freqmeter or monitor. The freqmeter is tuned to intermediate frequency higher or lower than the transmitting frequency and the signal comes out of the usual receiver output circuits.

"If it is too loud, coupling to the transmitter can be changed or, better still, just turn the regeneration control and shunt some of the signal voltage to ground. With all of the resistance cut out the signal goes to zero. This circuit arrangement also makes a good 'phone monitor.

"A few points about the operation: The strength and stability of the monitored signal is independent of the r.f. tuning adjustments of the receiver. It works up to within two or three kc. of the transmitting frequency before being blocked out, and can be used at the transmitting frequency if the plate voltage on the r.f. stage is cut off with a switch. The r.f. gain control can be used for similar results.

"Keying of the crystal oscillator in the cathode is one of the best ways of getting rid of key clicks, although even then some click filter usually is necessary. This system of monitoring and break-in is at its best only when key clicks are practically eliminated."

—···—

More on Switchless Monitoring

THE monitoring scheme outlined by W3EHE has the hearty endorsement of Roy A. Jenkins, W6RB, who worked out the same type of system independently for use with the regular non-regenerative type of superhet. W6RB makes no provision for introducing the transmitter signal into the receiver, depending upon stray pickup for the purpose. He writes:

"The method allows break-in, provides a constant check on actual signal transmission, requires no relays, no extra phones are needed, nor is any switching whatever used. The fact that the monitoring signal is the same strength regardless of the receiver setting is in itself enough to make this scheme desirable.

"To put it into operation, the receiver, transmitter and frequency meter are all allowed to warm up a bit. If the oscillator is not keyed, rotate the freqmeter dial until the beat against the transmitter is heard in the receiver. Turn the receiver dial just a bit and see if the beat disappears. If it does, turn the freqmeter dial until another beat, one which does not disappear when the receiver is tuned, is heard. The beat is then on the intermediate frequency of the receiver and must necessarily remain unchanged when the receiver is tuned. When the oscillator is keyed, the key must be closed but the succeeding stages need not be operating unless a louder signal is desired. It should not take longer than five minutes to make the whole test; after that changes can be made to secure proper signal strength in the receiver.

"One point worth mentioning is that the receiver is equipped with a crystal filter, only the two transformers of which are shielded. Since the phasing condenser, shorting switch, crystal holder and socket are all unshielded there may be more signal picked up in this receiver than in one with the intermediate stages fully shielded. It may be necessary in some cases to leave the shield cap off the first i.f. tube, couple a short wire to the grid leak and stick it out through the cabinet, or even couple the grid of the tube fairly tightly to the output of the freqmeter. Individual station equipment will require different adjustments.

"The oscillator here is keyed and perfect break-in can be used by holding the signal from the transmitter down to a level comparable to the received signal. This system was sought after primarily for listening to my sending while using a bug, but its other advantages are also important."

—···—

Monitoring Without a Monitor

HAMS using regenerative receivers have right at hand a means of monitoring their transmissions without providing any auxiliary apparatus except a tuning condenser and a switch. It can be done quite easily by following the diagram of Fig. 27, suggested and used by Dougall Whitburn, VK5BY. In this circuit — any regenerative circuit can be used instead of the tickler arrangement shown — the regular tuning condenser is represented by C_1 and the auxiliary condenser by C_2. For reception, switch *Sw* is open, cutting C_2 out of the circuit. When transmitting, *Sw* is closed, connecting C_2 in parallel with C_1, and the circuit is then tuned by means of C_2 to half the transmitter frequency so that the transmitted signal can be picked up on the second harmonic of the oscillating detector. Since the setting of C_1 is not disturbed, opening *Sw* again for reception leaves the receiver tuned to the station being worked.

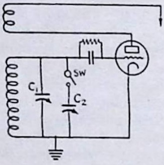


FIG. 27 — AN AUXILIARY TUNING CONDENSER AND SWITCH ADDED TO THE REGENERATIVE DETECTOR MAKE MONITORING OF TRANSMITTED SIGNALS POSSIBLE

The capacity required at C_2 will depend upon the constants of the tuned circuit. If C_1 is very small, a 150-μμfd. condenser at C_2 will be large enough to give the requisite tuning range. If the actual capacity used at C_1 to tune about to the center of a band is fairly large — say 50 or 100 μμfd. — C_2 should have a maximum capacity of three or four times the C_1 capacity in use.

—···—

Break-in Monitoring

A METHOD of continuous monitoring which works as instantaneously as the transmitting key, and at the same time eliminates the noise from the receiver so common on those systems which connect both monitor and receiver to a single pair of 'phones, is shown in Fig. 28. This scheme is a suggestion of C. W. Cashatt, W9JMX. Essentially, the method consists of a relay arrangement which disconnects the headset from the receiver when the key is pressed, the monitor being connected to the 'phones continuously. This arrangement is said to be noiseless, since the relay breaks only a small current in the 'phone circuit.

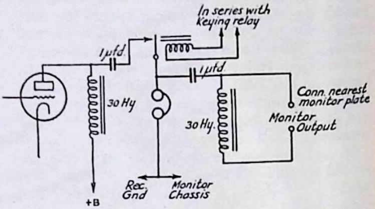


FIG. 28 — CONTINUOUS MONITORING WITH PROVISION FOR ELIMINATING RECEIVER NOISE WHEN TRANSMITTING

This circuit is readily applied when the transmitter is keyed through a relay.

Two audio chokes are necessary, one for the plate circuit of the receiver and the other for the monitor plate. The 'phones are condenser-coupled to both so that there is no d.c. in the 'phone circuit. The relay coil is connected in series with the keying relay, and the contacts should be arranged to open when the key is closed.

—···—

A Monitoring Kink

OWNERS of superhet receivers will be interested in this simple method of using their receivers as monitors. It is suggested by John N. Montgomery, 3rd, W8HWU, who writes:

"Here is a very simple monitor which costs nothing to build. Just place the send-receive switch in the lead from the first detector and r.f. tube cathode resistors to ground. When this circuit is broken the oscillator tube acts as a frequency meter-monitor when tuned to the local transmitter. This has worked on every super which we have tried it on, including several commercial receivers. It was tried originally to prevent r.f. in the antenna from burning out the r.f. gain control, but has worked so well as a monitor that I would not be without it. The only disadvantage is that the set has to be tuned to the transmitter in order that the signal may be heard on each transmission, which means that it must be retuned on each transmission during a QSO."

Single Control of Transmitter, Receiver and Monitor

The diagram of Fig. 29 shows a simple device used here to overcome one of the minor irritations of operating. It should appeal to lazy hams. The purpose is to make one switch on the receiver panel do three things: first, suspend the operation of the r.f. portion of the receiver, second, to put the monitor into operation and third to apply plate voltage to the whole transmitter. It is still necessary to key the transmitter, however. Besides performing these functions it will reduce the power consumption due to plate transformer and filter losses during listening periods, which with a large transmitter is no small item.

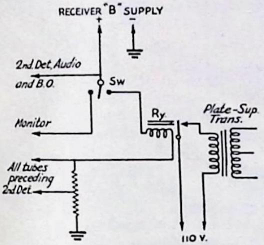


FIG. 29—ONE-OPERATION CONTROL OF RECEIVER, MONITOR AND TRANSMITTER PLATE SUPPLIES

The relay, Ry, is described in the text. The switch, Sw, is a s.p.d.t. toggle switch, mounted on the receiver panel.

Referring to the diagram, the relay used is a Yaxley automatic power control, originally intended for use with a battery receiver to cut a B-eliminator on and off. The coil was rewound with No. 36 wire, which happened to be convenient, until the spool was full, and gave positive action on about 25 mils. The two sets of contacts are operated in parallel to increase the current-carrying capacity. The monitor, which is an integral part of the receiver, consists of an electron-coupled oscillator tuned to the signal frequency plus or minus the intermediate frequency, and loosely coupled to the second detector. This beats with the beat-frequency oscillator and puts an audible frequency through the audio system. The panel switch is a three-way toggle switch. Otherwise the diagram is self-explanatory.

— *D. C. Ketcham, W4BBX*

—···—

Audio Oscillator Keying Monitor Without Relays

W8GPF offers a keying monitor system adaptable to any keyed stage. His description follows:—

"The advantages of listening to an audio note which is keyed at the same time the transmitter is keyed have been pointed out by many operators. For the ham who is just getting used to his mechanical key or the old-timer who sends at high speed and likes to hear his sending ripple in his ear, the system has universal appeal. In all of the *QST* articles I have read on this subject most fellows have approached the subject by using two 'phone jacks, one for the audio oscillator output and one for receiver output. Variations of this are the d.p.d.t. switch which shifts the cans from the audio oscillator to the receiver, and so on. One good system employed spare contacts on the keying relay which shifted the 'phones from one output circuit to the other. In the composite transmitter of the Goodyear Tire and Rubber Company at Wingfoot Lake our chief engineer, Mr. Birdsall, approached what I would call the utopian in this problem of what commercial radio calls 'howlers or side tones.' A keyed audio note is dumped into the 'phones when you are sending without having to touch a switch. It works in all cases. Those who cut the plate power on their receivers or those who use break-in operation can use this system.

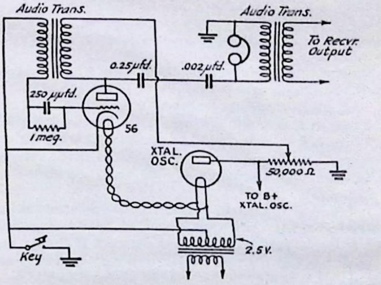


FIG. 30—AN AUDIO OSCILLATOR FOR KEYING MONITORING WHICH CAN BE KEYED WITHOUT RELAYS SIMULTANEOUSLY WITH THE TRANSMITTER

Practically any type of interstage audio transformer can be used. The tone of the oscillator can be varied to some extent by changing the value of the grid condenser or leak.

"As shown in the diagram, Fig. 30, the audio oscillator employs a 56 which is keyed in the cathode circuit. The cathode lead is connected to the side of the key which is intermittently grounded as you key the center tap of your transmitter. The output of the 56 is fed through a 0.25-μfd. condenser to the audio transformer, which can be any old audio transformer which does not attenuate the output from your receiver too much. None of the circuit constants are critical and the plate voltage of the 56 as well as the filament voltage can be obtained by tapping into the crystal oscillator stage."

It can be observed readily from the diagram that the audio oscillator can be connected to any keyed stage so long as the power supply for that stage has a bleeder from which a suitably low voltage can be tapped.

Sliding Bug Weight

It sometimes becomes necessary to change the speed adjustment of a bug during a QSO. Usually the set-screw on the weight is tight, and above all the operator gets a shock trying to change the dot adjustment. All this takes considerable time. Here's my way of solving the problem, and it may be helpful to others.

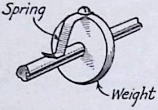


FIG. 31 — A SPRING CLIP ON THE BUG WEIGHT MAKES RAPID ADJUSTMENT EASY

A piece of spring brass with a hole in one end, such as a contact spring from the old type UX tube socket, is fastened to the weight with a short screw and the spring bent so as to place tension against the armature of the bug, as shown in Fig. 31.

The rest is simple. Whenever adjustment is desired it takes only one finger to reach over and slide the weight to any speed desired. If the spring tension is correct the weight will stay in any position indefinitely. — *D. B. Lane, W9BMA*

Making a Bug Key

A home-made bug which eliminates the machine shop, mechanical engineers, cranes, etc., which are usually required in the making of even the simplest home-made bug, is being used here at W6AVQ; and although it has a rather strange and startling appearance, it works quite decently and can be made in any well-equipped kitchen or bathroom with very little struggle.

Briefly, the idea is to use a straight key set up on its right side with a couple of angles for the main part of the animal, and screw the vibrating spring onto the end of the arm. Thus in one swoop the tough question of bearings, main arm and one of the springs is disposed of.

Fig. 32 gives all the necessary details. The universal clips used for weights are easily adjustable for various speeds. They are the type our Hartleys used to bristle with before Hull got on the job. The angles are from the 5 & 10. The light spring carrying the dot contact is a prong contact from a Benjamin spring socket. Almost any light spring would do here. The vibrator spring is a one-inch piece of half-inch corset stay, with one-quarter inch bent at a right angle (it must be bent slowly as it is brittle) and drilled or punched at the unbent end for the back adjustment screw on the key. It is clamped under the locknut on this screw. The screw is lock-nutted to the bent end of the vibrator spring; a hole should be punched and the vibrating arm fastened securely. The rubber band balances the tension of spring near the dash contact so that the arm comes back to a middle position after a flock of dots. A light spring under the adjusting screw at the back of the key would look less queer, undoubtedly. The two sets of contacts should, of course, be connected in parallel.

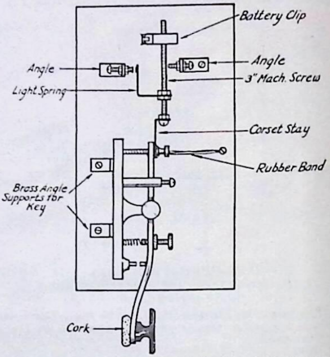


FIG. 32 — A BUG KEY MADE FROM AN ORDINARY HAND KEY

It was necessary to solder over each of the contacts on the dash end, making a solder to solder contact, as the high resistance of whatever Signal uses in his contacts made the dashes sound different from the dots (which have a low resistance path) in my monitor. A piece of cork glued to the under side of the regular knob makes the dot knob.

The adjustments of the thing call for much cut-and-try. The rubber band, the dash spring and the set screw at the back of the key are adjusted for about one-eighth-inch swing on the dot side and one-sixteenth on the dash side, with enough tension on each spring to bring the bar back firmly to the middle position. With the bar all the way over in the dot position, the contacts should touch with a slight tension on the spring carrying the dot contact. This makes a heavy dot. But the adjustments of home-made bugs have been explained many times; there is nothing different about this bug except the use of the straight key, which really makes the home-made bug a simple matter any ham can build. No more glass arms. . . . —*Frank Sullivan, W6AVQ*

6

Frequency Meters—Measurements

Freqmeter Calibration from B.C. Stations

Some of the fellows are unfamiliar with the fact that highly accurate frequency-meter calibrations can be obtained by utilizing signals that we have with us all day long and most of the night — every day of the year. Stations in the regular broadcast band are required to stay within 50 cycles of their assigned frequencies — better than .01% — and the fact that the assignments are all even multiples of 10 kc. makes it possible to get nice round figures for harmonic spots in the ham bands. We reprint here part of a note from E. Aymar, ex-W9HVA, outlining an excellent scheme for using the B.C. transmissions. The method requires only one easily-built oscillator in addition to the equipment ordinarily to be found in amateur stations, and can be used by anyone who knows what harmonics are and has a slight knowledge of arithmetic:

"The apparatus consist of two oscillators; one, the regular frequency meter, covering the 1715-kc. band; the second, using the same circuit, covering the broadcast band.

"The two oscillators, a receiver which can tune from 7000 to 8000 kc., and a B.C. receiver are all turned on, with the antenna posts strapped together. Let's tune in WLW on the B.C. receiver. Tune the broadcast oscillator to zero beat with WLW. Shut off the B.C. set. Now you could listen for the 5th harmonic on 3500, but there is an additional advantage in using the 10th at 7000 kc., as I will show later, though we found it most convenient to refer all readings to the 80-meter calibration chart. So we set the receiver near the edge of the 7000-kc. band, and then set the regular frequency meter to zero beat. This gives us one calibration point for the chart, which we will call 3500 kc.

"The same process will give us a 3550 point from WOR on 710, and a 3600 point from WGN on 720 kc. But that's not all.

"Since we are really listening in the 7000-kc. band, WLW will put an 11th harmonic on a point (7700 kc.) which when referred to the chart becomes 3850, and WOR gives us an additional point at 3905. Since we are working on the 3500-kc. curve we find it convenient to use the term '5½ harmonic,' although of course there actually is no such thing.

"The complete list of check points obtainable is much too long to write out here, but I'll tabulate a few so you can see how it goes. You can use practically every broadcast station for a check point by using one of the following harmonics: 3, 3½, 4, 4½, 5, 5½, 6."

……

Spotting Frequencies

In case some experimenters may be having difficulties in getting "located" in making up tuned circuits for ten and five meters, we print herewith a letter from D. R. Stark, W8DUO, which outlines the "adjacent-harmonic" method of determining the frequency on which the transmitter or receiver may be set. The problem of identifying the order of harmonic picked up from a calibrated frequency meter working on a low-frequency band is considerably simplified by using this method. It has been outlined in *QST*, but may have been overlooked or be unfamiliar to some. W8DUO writes:

"A calibrated frequency meter is used, in the following manner:

"Set the meter to 1750 kc. and tune for a harmonic in the receiver under test. Then, leaving the receiver set at this point, tune the freqmeter slowly higher in frequency until another signal is heard. Suppose the meter reading is now 1842 kc. Next subtract these figures, $(1842-1750)$ the difference being 92. Divide the larger figure by this difference $(1842 \div 92 = 20.02+)$. This result, approximately 20, is the number of the harmonic of the *first* freqmeter reading: — in other words, the 20th harmonic of 1750 kc., or 35,000 kc.

"Another example: The meter first reads 1750 kc., with the next reading 1823 kc.

"Solving:

$$1823-1750=73$$

$$1823 \div 73 = 25 \text{ (approximately)}$$

$$25 \times 1750 = 43{,}750.$$

"Obviously the freqmeter must be read carefully, so that the result of the simple division comes out close to a whole number. If the dial reading were accurate to a few decimal places, the figures would come out in even numbers, but the rough reading will serve our purpose.

"The freqmeter may have coverage on any band, so long as two harmonics can be heard, and they may be any two figures. It is convenient to start with 1750 kc. or 3500 kc., since harmonics will then come at the low-frequency edges of the different bands."

—···—

Extending the Freqmeter Calibration

Paul E. Griffith, W9DBW, 910-YA, State University of Iowa, at Iowa City, offers a practicable method of getting calibration points beyond the band limits.

"The amateur possessing a frequency-meter of the heterodyne type, calibrated in either the 1.75-Mc. or 3.5-Mc. band but operating in the 1.75-Mc. band, can easily extend its range on both sides of the band for which it is calibrated. All he needs is a receiver which will oscillate in the 14-Mc. band and an accurate calibration of his frequency meter.

"To find a point beyond the high-frequency end of the band, first multiply the frequency desired by seven and divide the product by eight. This will give the frequency in the calibrated portion of the band at which to set the meter. Set it there and tune your receiver until you find the eighth harmonic of this frequency, somewhere close to 14 Mc. Zero-beat it on the receiver and retune the frequency-meter to the other end of the band until a harmonic beats with the receiver. This will be the seventh harmonic of the freqmeter and will be the desired frequency that is outside the band on the h.f. end. If it is desired to find a frequency beyond the low-frequency end of the band, multiply the desired frequency by eight and divide the product by seven. This will give a setting of the meter in the high-frequency end of the calibrated portion of the band.

"An example may clear this up: Suppose it is desired to find the meter setting for 2020 kc. Multiply by seven: 7×2020=14140. Divide by eight: this gives 1767.5 kc., the point at which to set the frequency-meter. Zero-beat the harmonic of this and tune the meter past 2000 kc. until the next harmonic beats with the receiver. The point on the meter at which this occurs is the 2020-kc. calibration point.

—···—

Identifying the Freqmeter Signal on a Super

When a heterodyne frequency meter is used in conjunction with a superhet receiver it is easily possible to be misled in checking frequency because of the nature of the receiving method. One way of avoiding confusion is pointed out by C. L. Roach, VE2BT:

"In using a frequency meter with a superheterodyne receiver, there are at least two places on the freqmeter dial (assuming that it covers a sufficiently wide band), where a signal on the receiver may be brought to zero beat, as follows:

"(a) Where the freqmeter frequency equals that of the incoming signal.

"(b) Where the freqmeter frequency equals that of the h.f. oscillator in the receiver.

"The first condition is the correct one, and here is a way to determine which frequency the meter is generating:

"Adjust the freqmeter to zero beat with the incoming signal, the audio beat oscillator of the receiver, of course, being turned off. Then detune the receiver slightly, which will change the frequency of the h.f. oscillator a small amount. If the freqmeter is on the incoming signal frequency, it will stay on zero beat, but if it is on the h.f. oscillator frequency, an audible note will be heard, rising from zero as the receiver is detuned. With this condition, it is obvious that a different setting will be required on the freqmeter to get back to zero beat, and it is possible to obtain a number of zero beat readings, depending on the receiver setting."

The same thing is true if the frequency meter happens to be set on the image frequency of the signal being received. In other words, the frequency meter is set on the received signal *only* when tuning the receiver slightly causes no change in the beat note between the two, the receiver beat oscillator being off.

—···—

Finding the 28-Mc. Band

That ten-meter band, where is it? Cut and try on the coils but nothing doing, no signals except harmonics from the e.c. frequency meter.

If we could only tell which harmonic we are hearing! We are hunting for 30,000 kc., which is the 15th harmonic of 2000 kc. So tune the meter to 2000 and zero-beat the receiver on the harmonic. Leaving the receiver set, tune the frequency meter — another harmonic! That looks interesting. The frequency of the fundamental of this harmonic is 1875 kc.

While tuning up the old think tank trying to zero-beat an idea, we start to play with the slide rule.

Now a slide rule is used to multiply and we do that little stunt. First we multiply 2000 by a number so as to give 30,000, the frequency needed; that number is 15. Then we try 1875 — but look at that, we don't have to move the slide at all, as 16 is opposite 1875 and 16 times 1875 is 30,000.

Thus, if we wish to measure a frequency near 30,000 kc. we have only to note what two fundamental frequencies will have consecutive harmonics at that frequency; that is, as in the illustration above, the fifteenth and sixteenth harmonic of the respective fundamentals will be equal, i.e., 30,000 kc.

Run the slide along until two numbers coincide with the two fundamentals; then the end of the scale will indicate the frequency of the receiver. This stunt helped me on 14 mc. when a queer frequency jump occurred in my detector. It jumped right over the 14-mc. band, and only this method told me what was happening.

— *C. E. Marsh, W6FFU*

—···—

Freqmeter-Monitor with Dual-Purpose Tube

V. L. Daniels, W9IZL, Webster Electric Co., Racine, Wisconsin, has worked out an interesting application for the 6F7 tube as a combined electron-coupled oscillator and detector for the frequency-meter-monitor. The 6F7 is a new dual tube having a pentode and triode, entirely separate but using different sections of the same cathode, in one bulb. W9IZL uses the pentode portion of the tube as an electron-coupled oscillator and the triode as the detector. The circuit, complete with power supply, is given in Fig. 1.

W9IZL's frequency meter is contained in a metal box of small dimensions. The power-supply apparatus can be kept down in size because the current drain is very low. Midget chokes and power transformers will do very well, the total current required by the tube being less than 10 milliamperes. The pilot lamp across the filament of the tube serves as a reminder to turn off the power when the frequency meter is not in use.

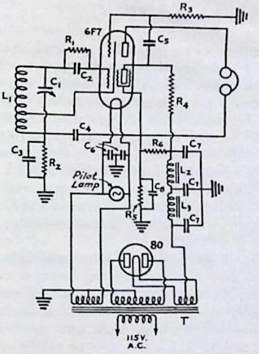


FIG. 1 — FREQUENCY-METER-MONITOR USING THE 6F7 TUBE

L_1, C_1 — Oscillator tank circuit. Preferably should be adjusted to cover the 1715–2000-kc. band with slight overlap at ends of tuning scale. Suggested constants are: for L_1, 90 turns No. 30 d.s.c. wire on 1-inch form, tapped 30th turn from lower end; for C_1, band-spread condenser having a minimum capacity of 50 μμfd. and maximum of 80 μμfd. The number of turns on L_1 should be adjusted to give suitable band-spread.

C_2 — 200 μμfd. mica condenser.

C_3, C_4 — .25 μfd.

C_5 — 0.002 μfd. mica condenser.

C_6 — 0.1 μfd.

C_7 — 8-μfd. electrolytic filter condensers.

C_8 — 1-μfd. electrolytic filter condensers.

R_1 — 100,000 ohms, 1 watt.

R_2 — 300 ohms, 1 watt.

R_3 — 1 megohm.

R_4 — 100,000 ohms, 1 watt.

R_5 — 20,000 ohms, 2 watt.

R_6 — 10,000 ohms, 2 watt.

L_2, L_3 — 20- to 30-henry, 25-ma. filter chokes.

T — Power transformer; high-voltage winding, 150 volts each side center tap; also 5-volt winding for 80 rectifier and 6.3-volt winding for 6F7 tube.

—···—

Single-Tube E.C. Freqmeter-Monitor

Some time ago while reading an article explaining the operation of the 2A7 tube, I was struck with the idea of adapting this tube for use as an e.c. frequency meter-monitor. Inasmuch as this tube was designed for a very similar purpose, it seemed quite logical to suppose that this tube might have some advantages not possessed by other tubes commonly used in frequency meters. What experiments I have made seem to bear out this supposition.

The circuit used is shown in Fig. 2. Condenser C_5 is a homemade one, the capacity of which is unknown to me. However its capacity is without doubt close to that of the General Radio 556,

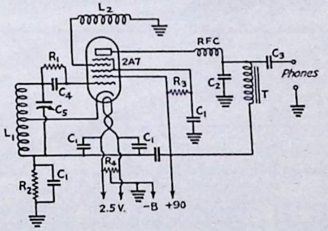


FIG. 2 — ELECTRON-COUPLED FREQUENCY-METER-MONITOR USING 2A7 TUBE

L_1 — 90 turns No. 28 d.c.c. on 1-inch form, tapped 30 turns from ground.

L_2 — See text.

R_1 — 10,000 ohms.

R_2 — 250 ohms.

R_3 — 50,000 ohms.

C_1 — .01-μfd. mica condenser.

C_2 — .0005-μfd. mica.

C_3 — .006-μfd. mica.

C_4 — .00025-μfd. mica.

C_5 — See text.

T — Audio transformer with primary and secondary in series.

RFC — See text.

since the inductance which it tunes is the same as that used in the frequency meter described in the *Handbook*. The radio frequency choke is a 3 to 1 a.f. transformer with the primary and secondary connected in series. Incidentally, it makes a difference in the effective impedance which way they are connected; I used an a.c. voltmeter to determine the right way. L_2 is the pick-up coil, and various sizes were tried here. As I use the frequency meter only for 80-meter band a coil of 65 turns (1-inch diameter) seemed to give the best results, but for other bands other sizes might prove to be better.

From my experiments the size of the pick-up coil doesn't seem to affect the frequency of the oscillator; indeed, it is possible to tune this coil with a variable condenser without affecting the frequency. The coil or even the grid cap of the tube may be touched with the hand without causing enough change in frequency to throw the oscillator off zero beat with either transmitter or receiver, and plugging headphones in or out has no apparent effect. The pick-up coil may be left outside the frequency meter-monitor shield box in order to obtain a good loud signal in the headphones. — *Lloyd L. Thornton, W8KDM*

* * *

Spreading Out the Calibration Curve

The accuracy with which frequency measurements are made depends to a large extent upon such purely mechanical things as precise reading of dials and calibration charts, as well as upon the goodness of the frequency meter itself. The use of a large sheet of cross-section paper and a large curve to make precise reading possible has therefore been recommended. But it is sometimes inconvenient to have to unfold a large curve sheet every time one wishes to take a reading, besides the difficulty of following accurately the lines from the margins to the curve without resorting to the use of a rule.

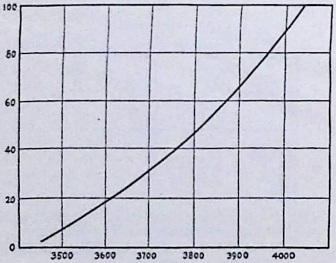


FIG. 3

A scheme called to our attention recently by one of our readers overcomes both of these objections nicely and makes it possible to fit a large curve into a small space as well as increase the ease of reading. It is best explained by reference to Figs. 3 and 4. In Fig. 3 we have a sample calibration curve occupying a 5 by 7 inch space on a sheet of ordinary cross-section paper, which has 20 lines to the inch. To avoid confusion only the lines spaced an inch apart are shown in the drawing. The calibration is assumed to cover the 3500-kc. band. This size of curve is easy to handle, but is difficult to read precisely because each dial division occupies only one-twentieth of an inch on the chart, and the nearest one can read is about a half division. The same is true of the frequency readings — the limit of precise reading is only about five kilocycles.

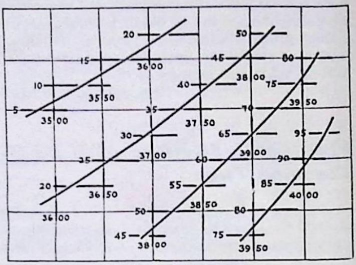


FIG. 4

In Fig. 4 the curve has been split into several sections, and the spacing has been doubled for both the dial and frequency readings, *without increasing the size of the sheet.* Each dial division now occupies a tenth of an inch, and the frequency can be read to 2½ kilocycles as easily as to five in Fig. 3. Besides this the chart is more easily followed because the values of ordinates and abscissas are plotted right on the curve.

The idea can of course be applied to any size of curve, and the sections may be chosen for the greatest convenience in use. For instance, the first section might include the phone band only, or might be drawn so that all of the 7- or 14-mc. harmonics would be on a single section.

In connection with plotting curves, it is a good idea to use a needle and make a small prick in the paper at the plotted points rather than to plot with a pencil. The advantages are obvious. The needle may be mounted in a wooden handle if many curves are to be drawn. Needless to say, the curve itself should be drawn with a hard pencil sharpened to a fine point or with a fine-pointed ruling pen, since a thick line is hard to read.

— *G. G.*

A Multi-Purpose Analyzer

THE basic circuit of the analyzer, shown in Fig. 5, is that of an elemental vacuum tube voltmeter. Inasmuch as most amateurs are interested in comparative tests, it is not necessary to calibrate it. This immediately simplifies construction and operation. When the 1½-volt cell is connected as shown, it supplies sufficient positive voltage to the plate of the tube to cause a plate current of approximately 80 microamperes to flow. If any audio or r.f. voltage is impressed on the grid, the plate current will increase as the applied voltage increases. As the one-milliampere meter used has a resistance of approximately 30 ohms, by the I^2R law we find it takes only 0.00003 watt (30 microwatts) to give a full scale deflection. It is evident that it takes very little input to give an appreciable reading. In fact, full scale on the meter requires less input than it takes to give a one-division indication on a current-squared galvanometer. If a tuned circuit is connected to the grid-filament, resonant at a desired radio frequency, it becomes apparent that we have a neutralizing meter *par excellence* at that frequency. In fact, it is so sensitive that it is all but impossible to get a minimum reading on the meter. Another point of interest is that the plate current is limited, since the plate potential is supplied by the filament cell. This makes it practically impossible to burn out the meter in a strong field. This is not true with instruments of the thermo-couple type, as many amateurs have found out to their sorrow.

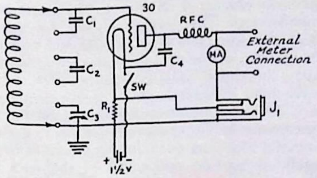
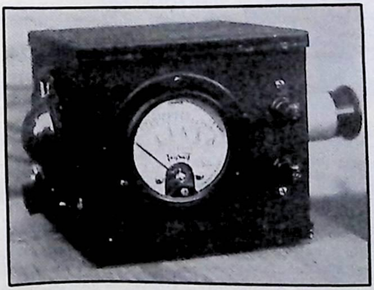


FIG. 5 — THE SIMPLE CIRCUIT OF THE ANALYZER

C_1 and C_2 — 50-μμfd. fixed mica condensers.
C_3 — 35-μμfd. midget variable.
C_4 — 500-μμfd. fixed mica by-pass.
RFC — 8-millihenry r.f. choke.
J_1 — Plate-battery jack, double circuit-closing type.
R_1 — 100,000-ohm ½- or 1-watt resistor.



THE HANDY ANALYZER IN ITS LITTLE CASE

The tuning dial is at the left end, the plug-in coil at the right. The binding posts are for external connections to the 0-1 milliammeter.

Another important use is the comparative measurement of antennas. Putting an ammeter in the center of a Hertz antenna and then giving it a haircut (the antenna, not the meter) is a laborious process. If the analyzer is set up near the free end of the antenna, in order to get as far as possible from the field of the transmitter and feeders, checking is much easier. If the amount of energy picked up is too small to give satisfactory readings, a short pick-up antenna may be connected to the grid side of the pick-up coil. The physical relation between the transmitting antenna and this wire should, of course, be kept constant during measurement. A crude indication of the field pattern may also be obtained by making checks of the meter readings at various points around the radiating system, thus putting the gadget to work as a field-strength meter.

With a resonant circuit required to develop the maximum voltage to secure the greatest sensitivity, it is evident that a calibrated absorption-type wavemeter is also provided as a feature at no additional cost. Some time ago this type of indicating device was the only one available for frequency measurement. Since the advent of the heterodyne type of frequency meter it has met with disfavor due to limited accuracy. While the heterodyne type of meter supplies a precisely-known fundamental frequency and a flock of harmonics, it is often a problem to identify the proper one.

The 35-μμfd. variable condenser and the two 50-μμfd. fixed condensers are connected to the six prongs of the sockets used for the plug-in coils. The filament terminals of the socket also connect to the grid and filament of the tube and the winding, of course, always connects to the filament terminals of the coil forms. By use of straps inside the different coil forms, between the pins, a wide variety of combinations of series and parallel condenser connections is available. The various combinations and the bands for which they are used, together with the approximate spread of each, are shown in Fig. 6. When a large band spread is available, care must be taken with the turns spacing. After the proper spacing is determined, the coils should be doped so that the relation between turns will not change.

With this device the frequency to which a receiver is tuned may be determined by the familiar "resonance click" method. Conversely, this is the method used in calibrating the various coil ranges. For transmitter measurements, with tube turned on the milliammeter can be read with the analyzer at a considerable distance from the transmitter.

Another important use is as an overmodulation indicator with which it is possible to determine easily whether the modulated amplifier or linear output amplifier is being operated properly. This is the reason for the cathode or filament bias resistor and the closed circuit jack which normally shorts out this resistor. If 135 volts of B battery are plugged into the jack, the bias resistor is automatically connected in the circuit and we have a linear detector. The plug should be in the jack before the battery is connected, as otherwise the batteries will short-circuit when the plug is inserted. Close coupling of the analyzer to the transmitter must now be avoided as the added plate potential supplies an ever-waiting current capable of wrapping the needle around the pin. "Kicks" with modulation show that there is over-shooting. It is obvious that by connecting 'phones in series with the batteries, an excellent listening monitor for 'phone is provided.

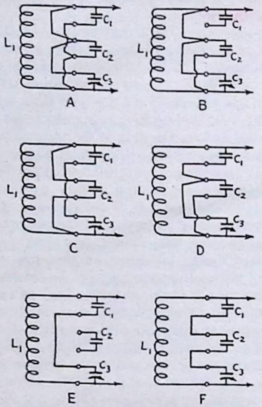


FIG. 6 — PIN CONNECTIONS AND COIL DATA FOR BAND-SPREAD TUNING OF THE ANALYZER

Diagram	*A*	*B*	*C*	*D*	*E*	*F*
Band, Kc.	*1750*	*3500*	*7000*	*14000*	*28000*	*56000*
Turns L_1	*50*	*27*	*12*	*7*	*4*	*1*
Divisions Spread	*95*	*80*	*70*	*80*	*60*	*70*

Still another use is as an output meter for receiver testing. By removing the coil and substituting a suitable resistance coupling unit, receivers of the superhet type may be readily aligned. Hum level may be checked and any improvement read directly on the meter.

Constructional details require little comment due to the simplicity of the analyzer. The only precaution necessary in the wiring to the coil socket, tube, and tuning condensers is to make all leads as short and direct as possible. The various pin straps within the coils should also be short, particularly in the high-frequency coils. The meter should be mounted and wired in last to eliminate chance of damage to the meter during construction. The circuit should be carefully checked before inserting the tube and turning on the battery, as one mistake will convert the meter into a corpse for lamentation.

We have in the completed instrument a compact device, completely self-contained for most measurements. External connections to the milliammeter alone are provided by means of the two insulated binding posts. All of the uses mentioned concern radio or audio frequencies. But every amateur is also interested in the various d.c. currents and voltages around the shack, not forgetting resistances which have a habit of losing their labels. Hence the one-mil meter used is a stock Triplett type which has, in addition to the usual linear scale, a number of voltage scales, together with an ohmmeter scale. A companion unit, also utilizing this meter, provides voltage, current, and resistance measurements covering practically every amateur requirement.

— *D. A. Griffin, W2AOE*

—···—

An Impedance Bridge

FIG. 7 is the circuit of an impedance bridge which I am sure many a ham would be able to use. I use it myself for balancing up *LC* circuits in the r.f. stages of receivers and for many similar purposes. The idea is to make up, say, the antenna coil and r.f. coupling coil of a short-wave super and connect one to each end of the bridge. If or when the inductances are equal there is no reading on the vacuum-tube voltmeter. Ganged condensers can be treated in the same way and checked right over their full scale. It is surprising what can be done in a tracking stunt like this. I have a super lined up with two r.f. stages and if you bend a grid lead out of shape it affects the a.v.c. meter.

A good method of checking is to use two resistances, one of 1000 ohms, fixed, and one variable to 1500 ohms. Connect the 1000-ohm standard to one pair of terminals (as 1 and 2) and the variable to the other pair; then find the point of balance on the 1500-ohm variable. Then if these are connected in series with the coils, condensers or resistors to be matched, you can tell at once whether it is a case of "too much or too little."

But before any measurements are made the bridge itself *must be balanced exactly*. This can be done by shorting terminals 1 and 2 together and

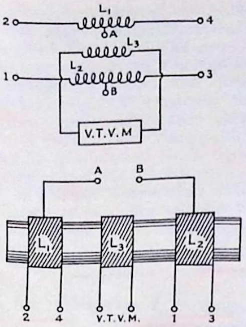


FIG. 7 — AN IMPEDANCE BRIDGE USEFUL FOR MATCHING COILS AND OTHER MEASUREMENT PURPOSES

L_1 and L_2 are each 30 microhenrys, centertapped; L_3 is the same without the center-tap. Various coil dimensions to give an inductance of 30 microhenrys can be secured by reference to the Lightning Calculator, Type A. For one-inch diameter tubing, a 30-µh. coil will have 32 turns of No. 30 d.s.c. or s.c.c. wire. It is advantageous to keep the coils small in the interests of maintaining circuit balance.

3 and 4 together. Make all coils alike and bring the circuit to balance by adjusting the coupling. The layout and leads should be as symmetrical as possible; a suggested arrangement is shown in the lower part of the drawing. The frequency I use, applied between terminals A and B, is approximately 500 kc. Don't forget body capacity when using the bridge. View it from a distance.

— *Maurice J. Kirk, Jamestown, S. Aust.*

—···—

A Simple Photographic Recorder

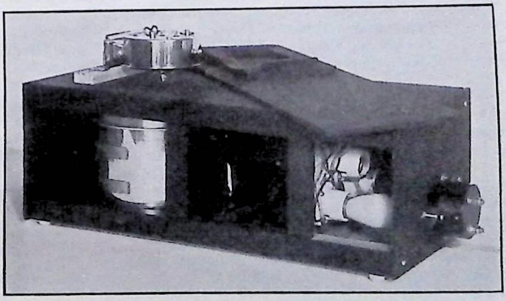
Here is a gadget which may be hitched to a receiver, power line or other source of changing voltage and left to itself to make a picture of everything that happens.

This recorder was evolved with the thought that the most desirable possible basis for the instrument would be an ordinary standard meter operating under normal conditions. The job of transferring the movements of the meter needle to paper is done photographically with the simple scheme shown in Fig. 8. In this arrangement, the face of the meter is illuminated by two 10-watt lamps. An image of the meter face is then thrown, by means of an ordinary camera lens, onto the side of a drum carrying sensitive paper. A slit is then arranged immediately in front of the drum so that everything on the meter face is eliminated except an extremely small slice of the calibration marks and the needle. Then, as the drum rotates, the calibration marks record as straight lines while the needle produces a "trace" corresponding to its movement.

It is futile to attempt to describe in detail the construction of this particular recorder. Dimensions will all vary in accordance with the focal length of the lens used, the size of drum available and the desired size of the recorded image. Then, most workers will have their own opinions with respect to constructional methods. It might be well, though, to cover some of the more important basic requirements.

In this design, it was considered that a paper speed of two inches an hour would take care of the slow signal variations found on the ultra-high frequencies. Search was therefore made for a drum having a circumference of about 24 inches. An aluminum saucepan with vertical sides proved to be ideal for the job. The next item was the lens. An old f 4.5 anastigmat of 3-inch focal length was located and set up experimentally to determine the necessary spacings between the meter face, lens and drum. This was facilitated by using the torn edge of a piece of paper, well illuminated, in place of the meter. In this instance, the drum, lens and meter were so arranged that the image of the meter was exactly the same size as the meter itself. In this way, the preparation of the slit was facilitated. Any cheap lens from a drugstore box camera could be used instead of the anastigmat providing the illumination is increased suitably.

With the main dimensions available, construction of the box was begun, its length being such that the meter could be mounted an inch or so



THE "HOME-BREW" SIGNAL RECORDER WITH THE SIDE PANEL REMOVED TO ALLOW RELOADING OF THE DRUM

Recorders built according to this very simple scheme might well be widely used by experimentally inclined amateurs interested in observation work.

away from the box end. By doing this, provision was made for accurate focussing and also for visual examination of the meter dial with the aid of a "dentist's mirror." Ply-wood was used throughout for the box, corner pieces being fitted to simplify construction and to avoid light leaks. The whole of one side was made removable so that the drum could be loaded conveniently and so that the lens or lamps could be adjusted or replaced.

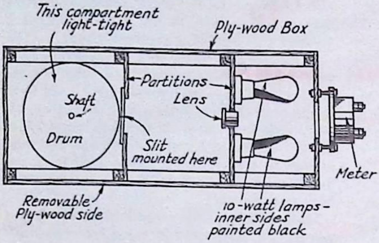


FIG. 8—A SECTIONAL VIEW OF THE RECORDER SHOWING THE ARRANGEMENT OF THE DRUM WITH RESPECT TO THE LENS AND METER

After locating accurately the center of the saucepan lid and bottom, a $\frac{3}{16}$-inch tapped brass rod was fitted for a shaft. Its lower end was made conical and supported in the end bearing of an old Cardwell condenser. The upper end of the shaft was connected with an ordinary flexible coupling to the hour-hand shaft of the clock. The paper clips on the drum were made from two pieces of thin brass rivetted at their centers to the drum wall.

Construction of the slit was simplified by using a piece of glass painted with Duco "Flat Black." The slit was then scratched with a pair of dividers set to the same radius as that of the meter calibration. The precise location of this slit is, of course, of prime importance. In our recorder it was set so that only the dial divisions representing tens of units crossed it.

A satisfactory sensitive paper for this work is known as "P.M.C. Bromide No. 1 Contrast." It may be developed with "Nepera Solution," or any of the scores of other paper developers available, and fixed in the usual acid fixer. The procedure is extremely simple and occupies but a few minutes.

Many possible changes in this design suggest themselves immediately. A more elaborate recorder we are now planning will have, for instance, a larger drum permitting a paper speed of four inches an hour. The drum will also be considerably higher and the focal length of the lens considerably longer. This will then permit the mounting of perhaps four or five meters one above the other so that simultaneous records may be made of several changing voltages. Some of the available meter holes may be filled with other instruments such as a hygrometer, barometer and thermometer. And that, by the way, is one very great advantage of this type of recorder, it will permit; the recording of many meters simultaneously, whether they be electrical meters or not, maintaining, all the while, the same order of accuracy inherent in the original instruments. Needless to say, the new recorder will have an electric clock movement in place of the present dollar's worth. —*R. A. H.*

—···—

Using a Voltmeter as an Ohmmeter

ARTICLES on the use of a low-scale milliammeter in conjunction with shunts and multiplying resistors as a multi-scale instrument have appeared in past *QST*'s. Many experimenters do not know that such an instrument, or any sensitive voltmeter for that matter, may be used as an ohmmeter without altering it in any way. All that is required is a source of e.m.f., such as a 22½-volt battery, and a knowledge of the combined resistance of the meter and the multiplier being used. Choose a voltage scale that will give nearly full scale deflection when measuring the voltage of the source. Call this reading V_i. Then insert the unknown resistance, R_x, in series with the meter and source and note the reduced reading which we will call V.

$$\text{Then } R_x=\frac{(V_i-V)}{V}R_m$$

where R_m is the total resistance of the voltmeter at the particular scale being used.

The formula can be explained as follows:

The difference between the readings V_i and V represents the voltage drop across the unknown resistance. This drop is the product of the unknown resistance and the current flowing through it. $V_i-V=I\times R_x$. If we divide the voltage drop by the current, we have the resistance. Since the unknown resistance and the meter are in series, the same current flows through each. The current can be determined from the meter reading as follows:

$$I=\frac{V}{R_m}$$

$$\text{Substituting, we have } V_i-V=\frac{V}{R_m}R_x$$

and solving for R_x, we have

$$R_x=\frac{V_i-V}{V}R_m$$

Where greater accuracy is desired, the resistance can be approximated as above and then a scale chosen so that the resistance of the corresponding multiplier is as near as possible to that of the resistance being measured. If the resistance is high, the source of e.m.f. may then be increased to give large scale deflections and permit more accurate readings to be taken. — *KA1NA*

—···—

Measuring Small Frequency Differences

In commercial power practice, the term "synchronism" is used to define that condition which exists when two or more alternating voltages are identical both in frequency and phase relationship. This condition of synchronism must be met when two or more alternators are used to feed a common load. For frequency *comparison*, or other purposes, the term "isochronism" is used defining the condition which exists when two or more alternating voltages are identical in frequency, but may or may not be in phase. The phase element is disregarded.

The usual method of adjusting two alternating voltages of high frequency to isochronism is by the "zero-beat" method with a headset in the output of a common detector. Because audio apparatus and the human ear will not respond to frequencies of a few cycles per second, a relatively wide region is present in which no beat note is heard — but at only *one* critical point are the two frequencies at absolute zero beat. For ordinary purposes, the aural method is sufficiently accurate, but to take full advantage of the various standard-frequency signals some electrical device must be substituted for the ear to obtain the same percentage of accuracy as the standard frequency. In other words, the high precision of the standard frequency transmissions is lost if the unknown frequency cannot be adjusted to absolute zero beat.

For the purpose of adjusting two frequencies to absolute zero beat, the outputs of two separate radio-frequency amplifiers are fed into a common detector, as shown in Fig. 9. The known frequency is coupled to one amplifier and the unknown source is coupled to the other amplifier. One or the other frequency, of course, must necessarily be variable. The potentiometers are provided so as not to overload the detector tube.

Fig. 9 shows the wiring diagram and constants of the various units. The input potentiometers are preferably of the carbonized-strip type. The coupling condensers are not critical in value and can be anything from 100 μμfd. to 0.005 μfd. The r.f. transformer constants depend upon the frequency band in which the apparatus is to be used. No tuning condensers are used; the windings should be of a value such that there is relatively-high inductive reactance at the operating frequency. Coupling should be very loose to the sources of radio-frequency voltage, such as through a small condenser, a few turns of a coil, or some such scheme. It is important that the coupling be as loose as possible, especially to a self-excited oscillator, so the frequency will not be affected. The detector is of the biased type. The meter can be permanently connected or, as in Fig. 9, a jack may be provided so that a meter need not be tied up in the apparatus. The meter need only be of such size as to determine the detector plate current conveniently, and can even be uncalibrated. The full-scale reading should be less than 5 milliamperes; a 0–1 milliammeter would be ideal. Construction should not offer any difficulties, and the isochrometer can be laid out to suit individual taste.

The instrument is used as follows: Each amplifier is loosely coupled to the different sources of radio-frequency voltage, and the potentiometers are adjusted for a convenient value of detector plate current. One or the other frequency is varied while listening in the 'phones for a beat note. The note is adjusted as closely as possible to zero beat while watching the needle on the meter. As the two frequencies approach isochronism, the needle will be seen to swing up and down at a rate equal to the difference frequency. The os-

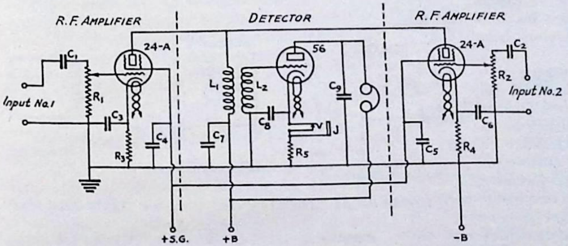


FIG. 9 — CIRCUIT DIAGRAM OF ISOCHROMETER OR ZERO-BEAT INDICATOR

C_1, C_2 — 0.002 μfd.
C_3, C_4, C_5, C_6 — 0.1 μfd.
C_7, C_8 — 1 μfd.
C_9 — 0.001 μfd.
R_1, R_2 — 250,000-ohm carbon-strip potentiometer.
R_3, R_4 — 500 ohms.
R_5 — 5000 ohms.
L_1, L_2 — Size depends upon frequency band in use. Use enough turns to be resonant around the operating frequency. Coils may be wound on same form and be plug-in if desired. Spare coils from receiver may also be used.

cillator or other source is then very carefully adjusted until the meter needle settles down to a constant value. At this point, the importance of shielding and coupling will become very apparent, and the various factors affecting frequency can be investigated readily while watching the meter.

Many uses suggest themselves, such for instance as determining the effect of keying or modulation of a transmitter on the frequency of the master oscillator. The master oscillator is coupled to one input of the isochrometer and a dynatron or electron-coupled frequency meter coupled to the other input. By first adjusting the two frequencies without keying or modulation, their respective effects upon the master oscillator frequency will be apparent by movement of the meter needle. Other applications would be in comparing the frequency drift of two frequency meters for the probable purpose of determining relative advantages and disadvantages of different types; the effect of load on an oscillator; in fact, in numerous applications where the objective is a *comparison* the isochrometer will be found very useful.

— *George J. Maki, ex-K7HV — W7HV*

—···—

A Multi-Purpose Test Circuit

EVERY experimenter has wanted, at one time or another, a test circuit built around a tube for various measuring purposes. Besides, hams still like to listen on the long waves and use the honeycomb relics around the shack. Here is an instrument for both uses.

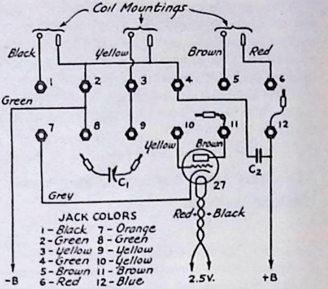


FIG. 10—CIRCUIT DIAGRAM OF THE MULTI-PURPOSE UNIT

Following is a list of the parts needed:

1 500-μμfd. variable condenser, C1. Should be calibrated if capacity measurements are to be made.
1 vernier dial.
3 honeycomb-coil mountings (two hinged to vary coupling).
12 insulated pin jacks, colored (Yaxley).
4 'phone tips.
1 5-prong tube socket.
1 .25-μfd. fixed condenser, C2.
1 Type 27 tube.
Four wire cable for power leads.
Set of honeycomb coils.
Metal cabinet.

The heart of the instrument is a calibrated variable condenser. I used a General Radio but removed the dial and used the variable ratio dial made by National instead. The latter dial has a convenient place for writing in the capacity calibration from the General Radio dial.

Only three circuits are suggested in Fig. 11, but any experimenter will think of others. The first circuit shows a regenerative detector using plug-in honeycomb coils. Besides its usefulness as a long-wave receiver, it is handy for calibrating. It is especially useful for the intermediate frequency bands of a home-built signal generator. You will use the fundamental and thus avoid mistakes caused by using the wrong harmonic. It is also valuable for calibrating a grid-dip oscillator.

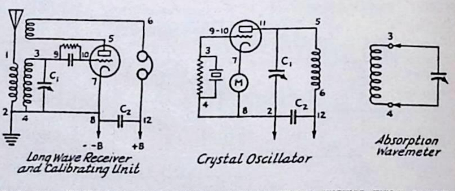


FIG. 11—TYPICAL CIRCUITS OBTAINABLE WITH THE UNIT

By simply doing a little plugging we have the crystal oscillator circuit shown. I use Yaxley insulated tip jacks because they will take either the banana type of plug or 'phone tips. The meter in the cathode circuit shows when the tuned circuit is in resonance with the crystal by a dip of the needle. This meter is inserted in the circuit simply by plugging your analyzer meter cords in pin jacks 7 and 8.

The other circuit shown is one of a simple inductance shunted by a calibrated variable condenser. It can be used as an amateur-band absorption wavemeter by plugging in a short-wave coil instead of a honeycomb. Then this inductance may be coupled to the detector coil of a short-wave regenerative receiver and resonance found by the click method, or it can be used with a neon bulb or small flash lamp plugged in series with the coil and condenser. Such a wavemeter is not as accurate as the heterodyne type but is useful in making certain that the transmitter is not tuned to a harmonic.

— *Jim Kirk, W6DEG*

7

Improving the Power Supply

Power Supply Delay Switch

MANY amateurs who do not have expensive equipment find two switches necessary for getting the rectifiers and the transmitter on the air. A slight alteration to a d.p.s.t. knife switch, as shown in Fig. 1, affords a simple and convenient way of providing a few seconds time delay for the mercury tube filaments to heat, yet only one switch is required.

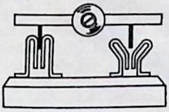


FIG. 1 — WITH ONE JAW OF THE POWER SWITCH BENT AS SHOWN, AND WITH THE CONNECTIONS DESCRIBED IN THE TEXT, THE FILAMENT POWER IS CERTAIN TO GO ON BEFORE THE PRIMARY CIRCUIT OF THE PLATE TRANSFORMER IS CLOSED

The filaments of the rectifier and transmitter tubes are controlled by the side making contact first, while the primary of the plate transformer is closed by the second contact. This combines all of the advantages of two separate switches, yet is simpler to operate. — *L. D. Miles, W2GGB*

— · · · —

"Shockless" Meter Jacks

SOME of the "brethren," who want to live as long as possible, may be interested in the following:

When using a single plate meter and single grid meter to service two or more stages in a transmitter, it is usual to connect the frames of one set of jacks to positive of plate supply and the frames of the other set to negative, which makes the front of the panel a very bad place for hands. The writer uses the four-spring, double-circuit type jack wired as shown in Fig. 2.

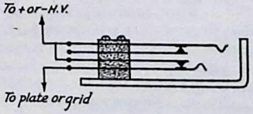


FIG. 2 — THE FRAMES OF UNUSED METER JACKS ARE "COLD" WHEN THIS CIRCUIT IS USED

The frame of this jack is "cold" except when the plug is inserted.

— *Neil E. Henry, W3BRY*

— · · · —

Inexpensive Fuses

EVERY amateur knows the desirability of protecting his equipment from accidental shorts and overloads.

A very satisfactory low-priced fuse, which can be "tailored" to fit practically any amateur application, may be made by procuring some lug terminal strips. These are sold at a very reasonable price and can be had with from two to six lugs. The fuse material is "Christmas Tree" tinsel or even the tinfoil from the popular brands of cigarettes. The strips of this material are fastened to, and wound around the lugs as shown in Fig. 3. This makes a dependable fuse, the current carrying capacity of which can be changed by varying the width of the tinfoil. The smaller the tinfoil, of course, the less current it will carry without blowing, and after a little experimenting the right size of strip to use can be determined quite accurately.

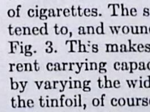


FIG. 3—HOMEMADE FUSE FOR TUBE CIRCUITS

The tinfoil should be pulled through the lugs and wrapped around them for connections. The width of the foil strip determines the current at which the foil will melt.

— *E. W. Hill, Fitchburg, Mass.*

— · · · —

Home-Made High-Voltage Fuses

FUSES for use on 5000 volts or more, as well as those for low voltage, may readily be made and calibrated for currents as low as a hundred mils.

Get a sheet of tinfoil from a paper condenser or from the wrapping of a photographic film. The thinner the foil, the better for low current fuses. Some of the foil used in paper condensers is bonded to the paper; this is unsuitable. If the foil has any wax on it, this should be removed with a solvent such as benzol or gasoline. Lay the sheet of tinfoil on a plate of glass and carefully rub out the wrinkles. With a steel scale or straight edge and a razor blade or other sharp knife cut strips a few hundredths of an inch in width. The proper angle at which to hold the razor blade may be found by trial; with a little practice very narrow strips may be cut. One of these strips is then inserted in a quarter inch glass tube and the ends of the strip bent over, as in Fig. 4-A. For a 5000-volt fuse a tube about 4 inches long will suffice. The strip of foil should be about an inch longer than the glass tube.

To complete the fuse, take two end caps from a grid leak and attach them as follows: Heat the caps until the low temperature alloy is melted and push the glass tube and its strip into the molten metal as at B. In case no such caps are at hand, they may be made from brass tubing or cast from solder. The low-melting alloy is the same as that used for mounting detector crystals. It is obvious that such fuses may be refilled an indefinite number of times.

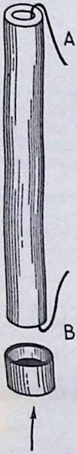


FIG. 4

The calibration of the fuse is carried out by connecting it in series with an ammeter or milliammeter of suitable scale, a sensitive rheostat, and a battery. As the current is increased, the fuse is watched carefully for any sign of heating. There will always be some narrowest point, and this will heat up first. When a faint red glow is seen, the instrument is read, and this reading is taken as the rating of the fuse. If the rheostat is further reduced in resistance, the current stays at almost this value until the fuse blows. The reason is that the resistance of the fuse increases with temperature so that the voltage drop across the fuse increases slightly thus preventing the current from rising.

All fuses of this type, consisting of a simple wire without de-ionizing devices, are properly used only on alternating current or on unfiltered rectified d.c., such as in the plate circuits of 866's and other high voltage rectifiers. There is a possibility of a continuous arc forming when the fuse is used in a pure d.c. circuit of over 250 volts, as for example, on the output side of a filter, because of lack of quenching of the ions formed when the fuse blows.

A de-ionizing agent such as silisic acid may be put in the tube around the fuse wire if the fuse is to be used on d.c. The writer has never tried out this scheme because there has been no occasion to use fuses on d.c., but the fuses made as described in the preceding paragraphs have given excellent results at W7EZL and represent a considerable saving when much experimental work is being done. — *E. A. Yunker, W7EZL*

—…—

Metering Several Stages

When economy is desirable in a multi-stage transmitter, it is common practice to use a single current-meter terminated with a plug which can be inserted in jacks connected in the circuits where one wants to read the plate or grid currents. If a common supply is used for the plate or grid voltages an alternate method suggested by the diagram, Fig. 5, may be employed. A dummy plug (metal rod or short circuited plug) is inserted into the jack of the circuit which it is desired to read.

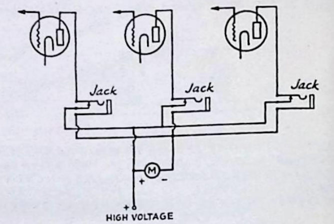


FIG. 5 — A PLUG-AND-JACK METERING SYSTEM IN WHICH NO FLEXIBLE CORD IS REQUIRED
Single closed-circuit jacks are used.

The necessary resistances to give the correct voltages to the different tubes may be placed in the circuit on the tube side of the jack. One meter should be used for the plate currents and, if desired, another for the grid currents. Western Electric uses this method in some of their equipment. — *W. B. Gould, 3rd, W1NP*

—…—

Insulating Filter Chokes

The following idea may be of some value to amateurs who have high-voltage power supplies to build. Instead of purchasing an expensive, high-voltage filter choke insulated to withstand umpty-ump thousand volts between winding and core, one can get along very nicely with any type of choke which has the desired current, resistance, and inductance rating, regardless of its voltage insulation. It is only necessary to mount the "under-insulated" choke on two or more sturdy stand-off insulators, so that its core and frame are isolated from any grounded circuit. The frame and core can be painted red if the operator fears that he may forget the status of this filter arrangement. A still safer procedure is to enclose the choke in a grounded metal box, the frame and core being insulated from the protective covering by the stand-off insulators. It might be decidedly unhealthy and not in the least conducive to longevity for the operator to touch the frame of said choke with himself grounded and the power supply in operation. This dodge, however, is certainly worth remembering as a shekel-saver. — *L. C. Waller, W2BRO*

—···—

Boosting Voltage

MANY power transformers, particularly those used with low-power transmitters, have unused filament windings. By connecting such a filament winding in series with the primary winding so that the voltage drop across the filament winding bucks that of the primary winding, the turns ratio is increased and a higher output voltage results.

To determine the proper connections, place an a.c. voltmeter across the secondary high-voltage winding and note voltage, then place one of the filament windings in series with the primary winding and note the change in voltage. If it increases the connection is correct, if not reverse the filament connections. More than one may be connected in series and then placed in series with the primary. If excessive heating is noted, it is advisable to cut out one or more bucking windings to prevent damage to the transformer.

I have used this kink for some time. The transformer in question normally supplied 1300 volts a.c. at 200 ma., and since placing one 2½ and one 7½-volt winding in series with the primary, the voltage increased to 1500 volts with the same load current without heating. The same scheme may be used to boost the voltage of a filament transformer. — *Dean C. Logan, W2GKZ*

—···—

Filament Voltage Regulator

MANY amateurs are troubled with poor line voltage regulation; also, when the key is pressed, the filament voltage drops, which is hard on the filaments.

To overcome these troubles the writer devised a system whereby the filament voltage could be regulated when the line voltage changed, and also be kept constant while keying. This system will compensate for changes of 18 volts each way from 110 volts, as well as changes in filament voltages of 10% caused by keying.

As shown in Fig. 6, the equipment needed includes an auto-transformer, T_1-T_2, a pair of variable resistors, R_1 and R_2, and a relay, Ry, which is connected in parallel with the keying relay. The auto-transformer is homemade, wound on a core measuring 1½ by 1½ by 5½ inches. The 110-volt winding consists of 510 turns of No. 20 s.c.e. wire, while the step-up winding, T_1, has 107 turns of No. 12 d.c.c. R_1 is a small 75-ohm wire-wound variable resistor; the voltage drop across it is low so its power rating need not be very large. For R_2 the writer uses a 500-ohm 250-watt Super-Power Clarostat. The relay is simply an automobile generator cut-out.

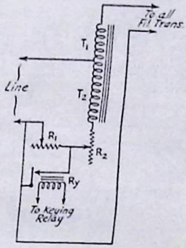


FIG. 6 — SYSTEM FOR COMPENSATING FOR FILAMENT-VOLTAGE DROP WHEN KEYING

Provision also is made for adjustment of the filament voltage to take care of line voltage variations.

To put the system into operation, turn R_1 so that all its resistance is cut out and adjust R_2 to give the proper filament voltage. This should be done with the plate power off. Then apply plate voltage, close the key, and note the drop in filament voltage. Remove the plate power and readjust R_2 until the filament voltage is as much above normal as it was below when plate power was applied, then adjust R_1 to give normal voltage once more. The filament voltage will then stay constant with keying. Line voltage variations can be compensated for by varying R_2; R_1 probably will not need to be touched again so long as the line voltage changes are not excessive. — *Victor Emmert, W6DVV*

—···—

Rectifier Switching for Voltage Changing

HAVING several plate voltages available is desirable not only from the standpoint of being able to change power to suit QRM conditions, but also for economical reasons, since the difference between one or two hundred watts and a kilowatt quickly shows up on the power bill. The switching arrangement shown in Fig. 7, used by J. O. Ellison, W8COW, is quite flexible in this respect. Two porcelain-base knife switches are required, one a d.p.d.t., and the other a t.p.d.t. By manipulation of the switches either center-tap or bridge rectification can be used, and the voltage taps on the transformer changed as well.

When both switches are in the upper position, the filament circuits of rectifiers 3 and 4 are closed and the four tubes are connected in bridge; the 1500-volt taps on the transformer are connected in the circuit so that the output is 3000 volts r.a.c. With Sw_1 down, the output is 2000 volts r.a.c., using the same bridge rectifier. With both Sw_2 and Sw_1 down, the filament circuits of tubes 3 and 4 are opened and tubes 1 and 2 are connected in the center-tap circuit. The output is 1000 volts r.a.c. If Sw_1 is now put in the upper position, the output voltage is 1500. The plate transformer must, of course, be capable of handling the power taken from the highest-voltage connection.

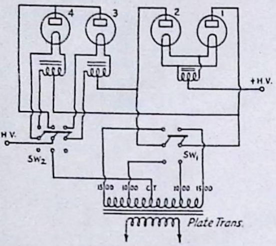


FIG. 7 — RECTIFIER SWITCHING CIRCUIT FOR VOLTAGE CHANGING

—...—

Simple Filament-Voltage Booster

PROBABLY some of the gang have been hesitant about trying some of the metal tubes in receivers because of the necessity for getting a separate 6.3-volt filament supply when the existing receiver is geared up for 2.5-volt tubes. W1CD has an inexpensive and simple solution to this one. The gadget is an auto-transformer, made by winding 100 turns of No. 20 wire on an old audio transformer core (every ham has one!). A tap is brought out at the 39th turn and the works connected as shown in Fig. 8. Both 2.5 and 6.3 volts are available.

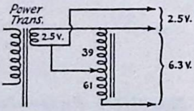


FIG. 8 — INEXPENSIVE AND EASILY-MADE BOOSTER TRANSFORMER FOR OPERATING 6.3-VOLT TUBES FROM A 2.5-VOLT SUPPLY

W1CD's transformer handles four 6.3-volt tubes, the other three in his receiver operating at 2.5 volts. He writes that from the way the transformer operates it would seem to be capable of handling the remaining three just as readily. It took about five minutes to build.

—...—

Power Supply for Multi-Stage Transmitters

THE question of economy in power supplies for multi-stage transmitters has always been quite a problem, since the differences in voltages required by succeeding stages usually make more than one power supply necessary. Voltage dividers may be used to obtain lower voltages, within certain limits, but where the voltages differ by any great amount a voltage divider consumes considerable power, besides having poor voltage regulation.

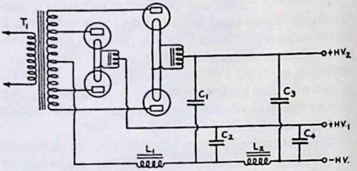


FIG. 9 — A POWER SUPPLY CIRCUIT IN WHICH A SINGLE TRANSFORMER AND SET OF FILTER CHOKES IS MADE TO SERVE FOR DIFFERENT VOLTAGES

Each voltage has its own rectifier and filter condensers. Although only two voltages are indicated, others may be obtained provided the transformer has the necessary taps.

The circuit shown in Fig. 9 was designed for use with multi-stage transmitters where the successive stages require much greater voltages in comparison to the voltages of the preceding stages. The cost of the equipment is considerably less since but one transformer and filter is required to produce several different voltages. Compactness is another advantageous feature of the circuit.

The transformer is center-tapped at the various voltages required. These voltages are rectified independently of each other and then filtered through a common filter whose chokes are in series with the center-tap or negative lead from the transformer. Transformers having taps at all the voltages likely to be required may be hard to obtain commercially, especially if more than two voltages are needed. One can be made especially for the job, however, or an old one can be rewound.

The rectifier performance will be improved if the input choke, L_1, is of the swinging variety instead of the ordinary type. Filter constants are not given since they will depend upon the voltages and currents to be handled. Design data can be found in the *Handbook*. The chokes must of course be built to handle the total direct current to be taken from all taps on the power supply.

The wave form was not studied by means of an oscillograph; however, two oscillators of different powers were rigged using the rectifier for power source. Either oscillator could be keyed without noticeable change in filtering. As true of any circuit the parts must be of the proper ratings with a suitable safety factor.

The circuit has been used at W7CNS and K7CKK for over two years with proved success. Several modifications were also tried out, but the circuit of Fig. 9 seemed to be most satisfactory.

This power supply will furnish voltages for any number of stages, from oscillator to final amplifier, although for a modulated transmitter it is suggested that two supplies be used, especially when dealing with large power.

— *E. E. Comstock, Ensign, U.S.S. Coast Guard*

—•••—

Combined Plate and Bias Pack

THE idea of making one plate transformer supply simultaneously plate and bias voltages through the use of two separate rectifiers, although described in *QST* many years ago, has had less application than it deserves. Here is some practical dope from M. C. Bartlett, W9JHY, who writes:

"I am enclosing a sketch (Fig. 10) of a power supply that solved a problem: That of getting a bias supply cheaply.

"I already had a crystal oscillator power supply and by buying one filament transformer, one choke, one more 83, an electrolytic condenser and a resistor, I had a perfectly good bias supply that avoided the objectionable features of grounding the middle of the bleeder resistor, involving poor regulation, high voltage drop, etc.

"This rig is suitable for use with transmitters having bias requirements up to 250 volts, and is the veritable 'nerts' for 852 tubes, or others requiring high bias values.

"At W9JHY this rig is used for the oscillator plate, and furnishes bias voltage for the whole transmitter, Class-B modulators and all."

The only point to be watched is to make certain that the high-voltage transformer can supply the additional power to be dissipated in the bias bleeder, which should have low resistance for the sake of good bias-voltage regulation. The total current in W9JHY's arrangement is in the neighborhood of 300 ma., assuming 250 ma. for the bias section and 50 ma. for the oscillator and its bleeder, R_3.

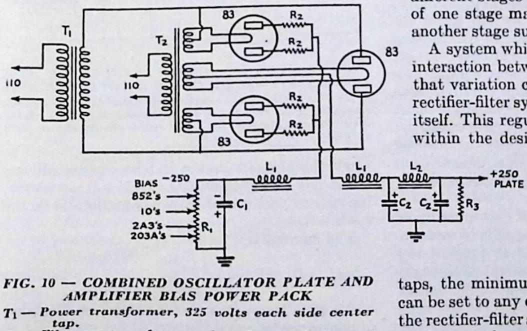


FIG. 10 — COMBINED OSCILLATOR PLATE AND AMPLIFIER BIAS POWER PACK

- *T_1 — Power transformer, 325 volts each side center tap.*
- *T_2 — Filament transformer, three 5-volt windings.*
- *L_1 — 5-15-henry swinging choke, 250 ma.*
- *L_2 — 25-henry smoothing choke, 150 ma.*
- *C_1 — 8-μfd. electrolytic (can not grounded).*
- *C_2 — Doubler 4-μfd. electrolytic.*
- *R_1 — 1000 ohms, 200 watts.*
- *R_2 — 100 ohms, 10-watt wire-wound.*
- *R_3 — 50,000 ohms, 10 watts.*

—•••—

Self-Regulating Bias Supply

LATE radio literature has described several methods and devices for attempting to prevent the "soaring grid bias" on power amplifiers using rectifier-filter types of grid bias sources.[1] Why should we prevent this change in grid bias? In some cases it is desirable to maintain perfectly fixed grid bias; but with most ordinary Class-C systems it is only necessary to have complete control over the grid bias at zero and maximum excitation of the amplifier tube. The thing which it is very desirable to prevent is interaction with the changing grid biases of several different stages of an amplifier. The operation of one stage may change the bias applied to another stage sufficiently to cause trouble.

A system which I have developed limits the interaction between the various stages only to that variation caused by the regulation of the rectifier-filter system of the bias voltage supply itself. This regulation can very easily be held within the desirable limits. The system is illustrated by Fig. 11. Each amplifier stage receives its grid bias from a separate anode of a diode rectifier tube connected, as shown, across the bias supply output. By the use of a resistor with two adjustable taps, the minimum and the maximum grid bias can be set to any desired value. When under load, the rectifier-filter system must supply at least the minimum voltage required for the biasing of the grid of the tube which requires the highest grid bias with no excitation applied.

---

[1] Yates, "Automatic Vacuum-Tube Regulation Control," *QST*, Sept., 1934; also, "874 Regulator," Experimenters' Section, same issue; Robinson, "Gaseous Voltage Regulators," *QST*, Jan., 1935; Priest and Olney, "Vacuum-Tube Voltage Regulators," *QST*, July, 1935. — EDITOR.

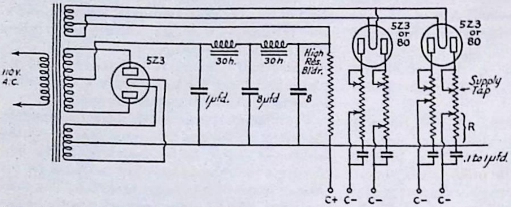


FIG. 11 — CIRCUIT ARRANGEMENT OF DIODE "VALVE ACTION" BIAS DIVIDERS FOR MULTI-STAGE TRANSMITTERS

Determination of resistance values is discussed in the text.

With no excitation applied to a Class-C amplifier, the bias may be adjusted so as to cut off the plate current. Simultaneously with the above condition, the resistance in each -C lead should have a value which will develop the desired maximum grid bias when the maximum grid current is flowing (maximum input condition). This value may be calculated by Ohm's Law:

$$R = \frac{E_g}{I_g},$$

where E_g = the maximum grid bias voltage desired and I_g = the (d.c.) grid current (in amperes) at full excitation. For instance, if a grid bias of 300 volts (maximum) is desired for a tube which will draw a grid current of 50 milliamperes (0.05 ampere), the resistance to which the bias tap should be set is

$$R = \frac{300}{0.05} = 6000 \text{ ohms}$$

The -C tap should first be set to approximately 6000 ohms; and then the supply tap (from the diode plate) should be set so that the bias applied to the grid without excitation will cause cut-off of the plate current. After the excitation has been applied and all current and voltage readings have been checked, any slight changes of adjustment which are found to be necessary may easily be made. After several stages have been connected to the bias supply some *slight* final adjustments may be found to be necessary in the biasing of the stages connected first.

Two very great advantages of this system are that in case of failure of the bias supply voltage, automatic bias will be effected as long as the amplifier is excited, and (the main advantage) that a low-voltage bias supply will suffice for an amplifier requiring a bias nearly double the voltage of the supply. The diode tubes prevent the bias voltage built up in the grid circuit from "backing up" into the lower voltage supply circuits and possibly breaking down the filter condensers, as well as from acting upon the grids of other tubes.

If Class-B stages must also be biased, the same voltage supply may also be used for this purpose. The difference in the design for the Class-B stage lies in the fact that the bias must remain very nearly constant and at such a value as to cut off (or nearly cut off) the Class-B stage plate current when no excitation is applied. This necessitates that the bias supply shall deliver a slightly higher voltage than that required to cause cut-off in the Class-B stage. For the Class-B stage, however, the required bias is only about half of that required for a Class-C stage, so that the same bias potential supply will usually suffice for both types.

To gain the required constancy of bias for amateur transmitter Class-B stages, the resistance *R* required may be calculated as before and then divided by about five. The voltage should then be set by the position of the supply tap, as before, except that the bias should not be raised above the plate current cut-off point.

If greater constancy for the bias of the Class-B stage is desired, its "valve action" diode may be changed to a triode of a low plate-resistance type, as shown in Fig. 12. The triode must be able to carry the current drawn by the resistor. If one triode (such as a '45 or '50 or 2A3) will not handle the current, several of them in parallel will do the work.

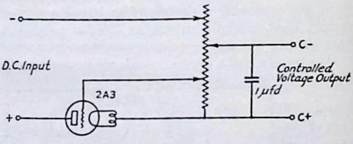


FIG. 12 — TRIODE SERIES REGULATOR FOR CLOSE CONTROL OF CLASS-B AMPLIFIER BIAS

As the grid of the regulator tube becomes more negative with respect to its filament, its series plate-filament resistance rises and holds down the output voltage.

The current is

$$I = \frac{E}{R}$$

where E = the supply voltage and R = the value of resistance between the supply tap and C+.

It will be noted that the triode must be connected in the positive lead; therefore, if more than one stage is to be biased by the same supply, either all must be operated from the same triode regulator and voltage divider; or, if separate triode regulators are used, the amplifier filament circuits must be entirely separate and ungrounded.

From this it may be easily seen that the diode method gives the more simple and fool-proof system of the two. It will supply controlled and protective bias for Class-C stages and nearly fixed bias for Class-B stages, without interaction between the bias acting on the various amplifiers; and only one rectifier-filter circuit is needed.

— *A. W. Friend, W8DSJ-W8KIU*

—···—

Combination Time Delay and Bias Supply

The circuit of Fig. 13 works very nicely as a time delay relay for mercury vapor rectifier tubes, and in addition serves as a transformerless "C" bias supply and automatic cut-off of high voltage in case of any failure in this supply.

To obtain the time delay feature, advantage is taken of the heater type of filament of the 25Z5 which was designed to operate as a voltage doubler directly off the 110-volt line. Two tubes are used in parallel to stand the drain through the low-resistance bleeder used to stabilize the "C" voltage, and to operate the heavy-duty relay that was at hand. Care should be taken to hook the plate and cathode connections at the tube sockets in the exact order shown in the diagram.

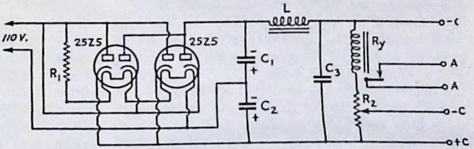


FIG. 13 — TIME-DELAY RELAY AND C-BIAS SUPPLY

C_1, C_2, C_3 — 8-μfd. electrolytics, 225-volts.
R_1 — 200 ohms, 25 watts.
L — 30-henry, 200-ma. choke.
Ry — S.p.s.t. relay.

A time delay of 17 seconds was obtained with the particular 25Z5s used. This will probably vary somewhat with the make of tubes.

Practically any d.c. relay that has contacts heavy enough to handle the current drawn by the plate transformers can be used. Telegraph relays or sounders might be fitted with heavy contacts or automobile generator cutouts revamped. To obtain good regulation as a C bias supply, 75 to 150 ma. bleeder load should be used. The particular relay at hand and value of bleeder resistor will have to be adjusted to secure this. If the relay has a resistance of several thousand ohms it can be used directly across the output of the filter; if of low resistance and operating on 75 to 150 ma. can be used as shown in the diagram. If it takes less than 75 ma. it can be shunted by a variable resistor, the latter being varied to give proper relay current, and the combination tied in series with the bleeder resistor.

In the unit constructed the relay required 140 ma. and the winding had a d.c. resistance of 150 ohms. With a bleeder resistor of 850 ohms in series the load current was 140 ma., with the voltage 140. A voltage of 165 could be secured at this load if C_1 and C_2 were increased to 16 μfd. each.

Many hours of life should be added to the tubes protected with this arrangement. A cut in the line voltage immediately opens the high voltage; a several-second cut will allow the filaments of the 25Z5s to cool slightly and there will be a delay before the high voltage is automatically reapplied.

There is one precaution to be observed: If the high voltage negatives are tied to direct ground it will be impossible to use this unit as a "C" supply, since it is necessary to connect the C positive to B negative. One side of the a.c. line is grounded and that shorts out C_1 and C_2. In this case the device would still be useful as a time delay relay, and one 25Z5 might prove sufficient to operate the relay.

— *Paul S. LeVan, W3MG*

—···—

Troubled with arcing between the leads below the press in small rectifier tubes such as the 83 and 81, VE3QH cured several of them by removing the base, cleaning the wires and then pouring in about an eighth inch of rubber cement. After the cement dried the rest of the glass stem was filled up with plaster of Paris and the base replaced. To remove the base, first unsolder the lead wires in the pins and then immerse the base in warm water, which will soften the cement which holds it to the glass.

—···—

When testing to see if a transformer winding is continuous, many hams are accustomed to using a small electric-light bulb connected in series with the 110-volt line. If the winding delivers high voltage the resistance may be too great to permit enough current to flow to light the lamp. In cases like this one of the small neon bulbs, substituted for the lamp, will make a good indicator, since the current taken by the neon bulb is minute.

— *W2BRY*

—···—

Universal Power Supply for Experimental Work

When doing experimental work, it seems inevitable that one never has at hand the facilities one needs. Particularly is this true in the case of power supply equipment, especially when working with receivers, audio amplifiers, and the like. In an attempt to cleave through this difficulty with one stroke I built a universal power supply which provides me with any voltage up to 400 on eight different terminals, with a maximum current drain of 235 ma. The maximum current drain was arrived at by subtracting the bleeder current (15 ma.) from the total capabilities of the unit, 250 ma.

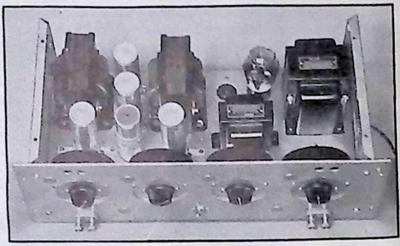
Four husky potentiometers provide as many variable voltages; their interconnections provide the same number of semi-fixed voltages. Variable voltages are thus available for every circuit element. To illustrate: by connecting terminal 1 (Fig. 14) to grid, 2 or 4 to cathode, variable grid bias of the "fixed" variety is obtainable. Plate, screen, and cathode grids can then be connected to any suitable one of the higher-voltage taps, also readily variable. Units requiring different plate or cathode voltages are easily accommodated. In fact, there is no requirement short of a 400-volt total potential difference that can't be met. Every terminal is heavily by-passed, both for filtering and to eliminate inter-coupling.

A 6-prong socket is provided for filament and variable plate voltages to facilitate use of a separate beat frequency oscillator and signal generator unit in connection with experimental work. A separate 16-μfd. condenser provides added filtering for this unit. The current reserve is ample to accommodate an ordinary receiver on test as well.

Construction is simplified by use of the General Radio punched panel, and chassis and end plate assembly. No dust cover is used because it would impair heat radiation — at times there is as much as 100 watts to be radiated.

Using the constants given, the hum is negligible, being less than one-half volt at the high-voltage terminal, with an even lower percentage on the lower terminals.

— *Clinton B. De Soto, W1CBD*



A POWER SUPPLY FOR EXPERIMENTAL WORK

Currents up to 200 ma. at any voltage up to 400, can be obtained. Voltages are readily adjustable through heavy duty potentiometers.

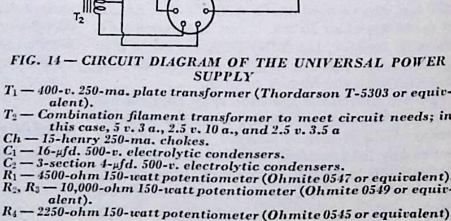


FIG. 14 — CIRCUIT DIAGRAM OF THE UNIVERSAL POWER SUPPLY

T_1 — 400-v. 250-ma. plate transformer (Thordarson T-5303 or equivalent).
T_2 — Combination filament transformer to meet circuit needs; in this case, 5 v. 3 a., 2.5 v. 10 a., and 2.5 v. 3.5 a
Ch — 15-henry 250-ma. chokes.
C_1 — 16-μfd. 500-v. electrolytic condensers.
C_2 — 3-section 4-μfd. 500-v. electrolytic condensers.
R_1 — 4500-ohm 150-watt potentiometer (Ohmite 0547 or equivalent).
R_2, R_3 — 10,000-ohm 150-watt potentiometer (Ohmite 0549 or equivalent).
R_4 — 2250-ohm 150-watt potentiometer (Ohmite 0545 or equivalent).

—···—

An Economical Filter Arrangement

When a single power supply is used for a high-voltage amplifier and low-voltage buffers, the circuit of Fig. 15 will provide adequate filtering for the high-voltage circuit with only a single filter condenser of maximum voltage rating. Usually a single high-voltage condenser is insufficient to give pure d.c. on the amplifier stage, and in many cases the expense of extra condensers is too great for a slim pocketbook.

In Fig. 15, the output of the rectifier feeds into the high-voltage condenser, C_1, thence to the choke and the bleeder resistor, *R*. A tap is taken off *R* for the low voltage, and additional filter, using condensers of lower rating, is provided by C_2, C_3 and the second choke. The low-voltage filter is thereby made to improve the smoothing in the high-voltage section. Condenser C_2 normally will have a rating of 500 to 800 volts and should have a capacity of about 4μfd.

I have had this filter in operation for quite some time and can get the same S9 reports on either low or high voltage. With only one high-voltage condenser and choke, however, the note is harsh. The system is now in use at a number of St. Louis stations, and is a blessing to the ham who can't afford high-voltage filter equipment.

— *Arbie Willis, W9NEV*

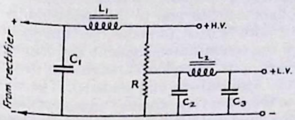


FIG. 15 — A COMBINED HIGH- AND LOW-VOLTAGE POWER SUPPLY IN WHICH A LOW-VOLTAGE FILTER CONTRIBUTES TO THE SMOOTHING IN THE HIGH-VOLTAGE SECTION

C_1 is a single high-voltage condenser of rating suitable for the output voltage of the rectifier. Resistor R should be between 35,000 and 50,000 ohms, with the tap taken off at the proper point to deliver 500 volts to the driver tubes. Condensers C_2 and C_3 should be rated at 800 volts, C_2 being 4μfd. and C_3 2μfd. Choke values are as in ordinary filter circuits. An input choke may be used if desired. The choke and C_3 in the low-voltage circuit can be omitted, but provide additional filtering for the small tubes.

—···—

Safe Starting and Excitation-Failure Protection

Many arrangements have been devised to prevent the careless operator from switching the plate and filament transformers on simultaneously. All that have come to our attention have some shortcoming footnoted. The arrangement used at W6EZY not only protects cold filaments but cuts the plate voltage if anything goes wrong back of the final amplifier. The foundation is the famous Philco AB relay switch rewound, hooked up as shown in Fig. 16. The holding coil, L_2, has 600 turns of No. 28 wire and is designed to release at 100 mils. L_1 is the starting coil, an audio transformer primary, which operates the relay snappily on 45 volts.

To operate, push the start button. If the main-line switch is closed the filaments will be hot, and grid current through L_2 will hold the relay. Anything that interrupts the flow of grid current through L_1 will release the armature. Shorting L_2 with the stop button does likewise. L_1 and L_2 are of course wound to assist.

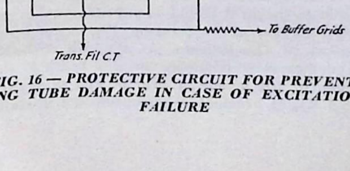


FIG. 16 — PROTECTIVE CIRCUIT FOR PREVENTING TUBE DAMAGE IN CASE OF EXCITATION FAILURE

Since the contacts on the Philco switch are not intended for heavy loads, they should be replaced by heavier silver contacts, depending upon the plate-transformer load. The resistors in series with the amplifier and buffer grid leads are the usual grid leads to provide additional bias under operating conditions.

— *L. M. Turner, W6EZY*

—···—

Overload Protection

Fig. 17 is the diagram of a kink used at W4BZX for a simple, cheap, and quite effective method of overload protection.

The heart of the circuit is relay Ry_2, which is one of the type originally used with d.c. receivers to turn off the A battery trickle charger and turn on the B battery eliminator automatically when the filament circuit in the set was closed, the relay coil being of rather low resistance and connected in series with the filament circuit. The relay is revamped by connecting as shown in the diagram and using only the contacts normally closed. Since the relay will operate on 300 milliamperes, a rheostat of 15 ohms is shunted across the coil to adjust for the desired operating current.

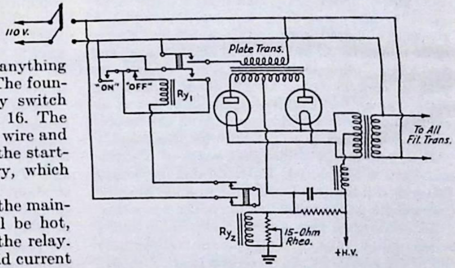


FIG. 17 — OVERLOAD PROTECTION WITH PUSH-BUTTON CONTROL

The overload relay, Ry_2, is a unit taken from an old "AB" eliminator.

Operation is something like this: The transmitter filaments are lighted by closing the master switch, while relay Ry_1 serves to turn on the high voltage. It is controlled by the "On" and "Off" push buttons, which are located on the operating table and connected to the transmitter by a three-wire cable. The double-pole relay Ry_1, with a 110-volt a.c. coil, has one of its contacts in the primary circuit of the high voltage transformer, while the other contact serves to lock the relay closed once the momentary-contact "On" push button has been depressed. The high voltage is normally turned off by pressing the "off" button, which is of the closed circuit type, and which, when pressed, breaks the holding circuit of relay Ry_1.

When an overload occurs, relay Ry_2 operates, instantaneously breaking the holding circuit of relay Ry_1, and allowing the contacts of Ry_1 to open. To apply the high voltage again, it is only necessary to press the start button, since Ry_2 is normally closed and immediately resets itself when the overload is removed; thus the necessity of having to get up from the operating position to reset the relay on the transmitter (if separated from operating position) is avoided.

The overload protection has really been worth the small trouble it took to install it, particularly so when troubled by "arc-overs." The system may be of value to others needing an inexpensive and effective method of overload protection.

— *R. D. Lambert, Jr., W4BZX*

—···—

A.C. from D.C. Generators

Amateurs who are isolated from a.c. or might like to have an auxiliary a.c. power supply for portable or emergency use may be interested in the system used at W4AVR for obtaining a.c. from a d.c. generator.

The only source of power here is a 750-watt 32-volt Delco farm-lighting plant. By a slight alteration of the generator, however, enough a.c. ower is obtained to run all filaments and supply late power for all but the final stage of a crystal ontrolled *'phone-c.w.* transmitter ending up with a 75-watt tube. Dynamotors supply the plate voltage for the final stage, since I was already in possession of them and saved the trouble of building an a.c. power supply for this stage.

It is possible to obtain 350 watts of 60-cycle a.c. from a four-brush 750-watt d.c. generator (25-cycle if it is a two-brush job), and at the same time get d.c. at the rated voltage of the generator.

To accomplish this a pair of slip rings and a brush rigging must be added to the commutator end of the armature. An extension shaft, 5 inches long and ½-inch in diameter, threaded at the free end, was attached to carry the rings. The shaft here was made from an old Chevrolet fan shaft.

A number of discs, 2¼ inches in diameter, with ½-inch holes in the center, were cut from old bakelite panels and slipped over the extension shaft. They are held securely in place by the nut on the end of the shaft. The slip rings were made from brass tubing of 2-inch inside diameter with ⅛-inch walls. The rings are 1½ inches wide.

The group of bakelite discs, or drum, was turned down while the generator was running so that the slip rings would fit tightly on the insulated shaft. The rings are separated about ¼-inch so that there is no danger of a short circuit. A ⅛-inch hole is drilled through the insulation parallel to the shaft to carry the wire from the commutator to the outside slip-ring. A 1/16-inch hole is drilled ¼-inch deep in one of the commutator bars near the hole in the insulation. No. 14 copper wire is used to make the connection between the commutator segment and the outside slip-ring; it is threaded through the insulation and the connections well soldered. The connection to the other ring is made to a commutator bar exactly one-fourth the way around the commutator from the other segment.

The brush rigging here is made from old automobile generator brush holders, two regular auto-generator brushes being used to each slip-ring. The brush rigging must be insulated from the frame of the generator.

The d.c. voltage taken from the armature is of the order of 38 volts at a speed of 1800 r.p.m. The r.m.s. value of the a.c. voltage (which must be used in making calculations for winding transformers) is, therefore, approximately 27 volts. As there is some loss in the windings the transformer primaries are designed for 25 volts. Wire of sufficient size to carry the current must be used, No. 14 being about right for the primary of a 300-watt transformer.

If the d.c. generator is a two-brush job, the slip-ring connections should be made to commutator segments exactly opposite each other on the commutator. The a.c. taken from such a generator will be of the order of 25 cycles at a speed of 1500 r.p.m. The transformers will, of course, have to be designed for 25 cycles. Additional dope on transformer winding may be found in *The Radio Amateur's Handbook.*

About 75 watts of 60-cycle a.c. may be taken from a Ford power-house type auto generator, which is of the four-brush variety. This is about the only four-brush automobile generator available. The a.c. r.m.s. voltage from such a generator is about 5.6 volts, so the transformer primary should be designed for 5 volts. The current will be about 12 amperes, so the wire used in winding the primary should be No. 12 enameled. A transformer with a core cross-section of one square inch is large enough to handle the output of a 6-volt auto-generator, and if standard core material is used 7 turns per volt will be about right for the windings. The primary should consist of 35 turns and the number of turns on the secondary would be the desired voltage multiplied by 7. The size wire used in winding the secondary is, of course, determined by the amount of current taken from the secondary winding; No. 30 is OK for 300 volts each side of the center tap.

If the generator is left running all the time while on the air it will be found necessary to use some means of suppressing the interference caused by the brushes. At W4AVR a 1-μfd. condenser is used across the d.c. brushes; the frame of the generator also is well grounded. Two ½-μfd. condensers are connected in series across the a.c. brushes and the center tap is run to a separate ground. If severe interference is encountered it may be necessary to use heavy r.f. chokes, consisting of 150 turns of No. 10 wire on a 2-inch form, in series with each of the leads carrying the output of the generator.

— *Wilbur Jackson, W4AVR*

—···—

A Junk-Box Voltage Regulator for the M.G.

Those who use a motor generator for plate supply and require close regulation will be interested in this voltage regulator, which cost 15 cents at the five-and-ten. The 15 cents was expended for two tungsten contact points (Ford) and a bird-cage spring. The rest of it comes from the junk pile. It is conventional in every way; see Signal Corps Pamphlet No. 40, 1921, page 190. The heart of it is an ancient audio transformer, a Thordarson 6-to-1 in this instance.

The diagram, Fig. 18, is slightly clarified from the Signal Corps description. In operation the field rheostat of the generator is short-circuited by the contacts as the line voltage rises and falls about a given point, determined by the tension of the spring. The core of the transformer is reformed into a W-section across which the vibrating armature is hung by taking out one leg. The primary and secondary of the audio transformer provide the control and bucking coil of the instrument, with suitable resistances in series with each to hold the current to safe operating values.

In the instrument I describe, the secondary of the transformer is the control magnet (b). It is connected directly across the line, with 3000 ohms in series. As the voltage of the line rises, the control magnet opens the contacts, making the rheostat operative in the shunt field of the generator. This causes the voltage of the generator to fall, which weakens the control magnet and allows the spring to close the contacts again. The cycle repeats itself rapidly, causing the line voltage to float about a given point, at any point on the line to which the regulator is attached.

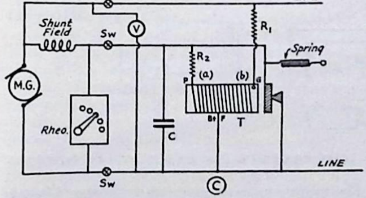


FIG. 18 — VOLTAGE REGULATOR FOR THE MOTOR-GENERATOR SET MADE FROM AN AUDIO TRANSFORMER AND FORD CONTACTS

T — 6-1 audio transformer (Thordarson). Secondary winding at (b); primary winding at (a).
R_1 — 3000 ohms.
R_2 — 5000 ohms.
C — 2 μfd., 400-volt rating.

The bucking coil *a* (the primary of the transformer) refines and quickens the action. When the contacts are closed, both the field rheostat and the bucking coil (connected in reverse across the rheostat) are short-circuited and inoperative. When the contacts open, both become operative. The bucking coil demagnetizes the core, but its inductive lag delays this action long enough to permit the non-inductive resistance of the field rheostat to operate. Properly adjusted, this device will hold the voltage within a fraction of a volt about the desired point, within the capacity of the generator and prime mover. Each winding requires only a few milliamperes. The best operating density for the reverse winding can be determined by varying the resistance in series with this winding. The one described uses 5000 ohms. A reversing switch across the contacts permits them to wear evenly, although at 5 cents each the cost of renewal is not excessive.

The device described has been in 24-hours-a-day service for three months on a 3.5-kw. 125-volt water-wheel driven generator used for lights and small power; and its regulating properties are such that it controls the voltage perfectly from full load to runaway speed. The original contacts are still in use. They should be set very close — 0.02 inch or less — as the travel is very small.

In the audio-frequency transformer used here *G* is connected to the line and *P* to a point between the field rheostat and the shunt field. *B* and *F* are joined together by a jumper and connected to the other side of the line at point *C*. To determine the size of condenser across the contacts, operate the device near a.b.c. receiver, adding capacity until a quiet point is reached. I use a 2-μfd. 400-volt condenser.

To put the regulator in operation, turn the field rheostat back until it gives desired voltage across the line at runaway speed. Then switch in the regulator, and adjust the spring until the voltmeter shows the desired voltage.

— *F. I. Anderson, New Boston, Mass.*

—···—

A Portable Power Supply

Several ways of getting plate power from low-voltage d.c. for a small transmitter have been described in past issues of *QST*. A simplified arrangement operating on the vibrator-transformer principle has been worked out by A. P. and I. L. Brown, W8VJ-W8IDE, so that no special apparatus is needed — further, the power supply can be used on a regular a.c. line when such a line is available. In brief, the idea is to use an ordinary small power transformer, hook up the rectifier and filter in the regular way, and connect a 6-volt storage battery in series with a Ford spark coil to one of the unused filament windings on the transformer, preferably a 5-volt winding. When a.c. is available the regular primary is connected to the line. Fig. 19 gives the details.

W8VJ recommends that the transformer be one giving about 300 volts each side of the center-tap. The power supply as shown would be suitable for a low-power transmitter, but by the addition of a second filter choke and a third 8-μfd. condenser section it can be used to supply a receiver. In the latter case it has been found advisable to put the Ford coil in a grounded metal can to help cut out the "hash" from the vibrator. Filaments of the tubes used in the receiver or transmitter can be supplied with power.

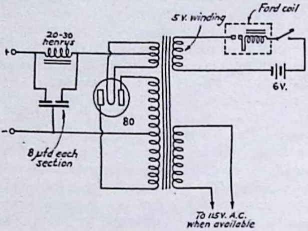


FIG. 19 — POWER SUPPLY, FOR A SMALL TRANSMITTER OR RECEIVER, WHICH WILL OPERATE FROM EITHER A SIX-VOLT STORAGE BATTERY OR AN A.C. LINE

High Voltage from 32 Volts D.C.

Hams without access to commercial power but having 32 volts d.c. available will be interested in the power supply used at W9KUI. The set-up described is the result of a couple years spent experimenting on various types of power supplies for 32-volt systems. Among others, a home-grown motor-generator was tried, but its efficiency was terrible.

The supply used now is relatively efficient, easy to build and is entirely satisfactory. It supplies 35 watts to a pair of 45's with 375 volts at 95 mils. This supply consistently brings better QRI reports to the same transmitter than my previous supply which had 24 mikes and 3 chokes. In 31 contacts on 80-meter c.w., not counting two contacts made with the choke shorted out, tone has been reported as T8 once, at all other times T9, sixteen of which were T9X.

The lay-out consists mainly of an altered Stancor ten-tube transformer P949, having a 110-volt primary, 700-volt 120-ma. center-tapped secondary, 6.3-volt secondary and a 5-volt secondary. The idea is to change the 110-volt primary to adapt it to 32 volts. The fiber mount carrying the soldering lugs is removed, also the half shell. Without removing the laminations, cut the wire in the two low-voltage secondaries and remove them, being careful not to damage the 110-volt primary which is underneath. Remove three layers of the primary and about 10 turns of the fourth. Remove a little of the insulation under these ten turns exposing the fifth layer. This gives you three taps on your primary, one at the end of the coil, another at edge of the fourth layer where wire goes to fifth layer, and the third tap is where the fifth layer was uncovered by removing those ten turns. Experiment to find which tap works best. Using too few turns in the primary causes excessive sparking at the vibrator points. I use the middle tap. This primary is put in series with a Ford coil. The high-voltage terminal of the coil is not used. The success of this supply depends largely on the buzzer adjustments. Put a toothpick under the brass reed of the stationary contact. Connect your transmitter to the set-up for a load. A high-range voltmeter or other means of noting results is necessary. With the buzzer running, voltage will probably be about 150. Now, take another toothpick, place it between the core and the vibrating reed and gently push the reed toward the stationary contact. The voltage will rise sharply. This second toothpick is only temporary, to show what results may be expected. To make the permanent spacer, cut strips of thin QSLs about 1 inch by 1½-inches and place them between core ending and vibrator. The idea is to dampen the vibrations so as to increase the period of time that current flows during each cycle. I use two strips and get a fine adjustment by sliding a smaller third strip up and down between the two. There should be very little sparking at the points.

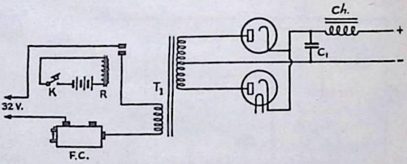


FIG. 20—COMPONENTS ARE DESCRIBED IN THE TEXT

The vibrator should give out a vigorous buzz. It will pay to spend plenty of time experimenting with different thicknesses of paper and adjustments of the thumb screw. A fraction of a turn from where it works best, the points start arcing. You must have good points. They cost only a nickel a pair so have some spares.

A little arcing usually spoils them in short order.

I have taken 40 watts from this outfit, but it is more stable at 35. I use 36 volts input, usually, sometimes only 30, which gives 30 watts output from the supply.

The keying relay is a Ford cut-out, stripped of wire and rewound full of No. 32 d.c.c. wire. A 1-µfd. condenser across the keying points may be advisable. The rectifiers are a pair of Type 1s. Full-wave rectification is used. Half-wave rectification didn't work at all. The filter consists of a 1-µfd. electrolytic and an overloaded 30-henry choke. At first thought, this would seem inadequate, but the high-frequency supply filters very easily.

A single 6Z4 was used for a while, but it gave considerably less output. The regulation was poor and it was necessary to have sufficient load on it to hold the voltage down.

The vibrator adjustment makes a lot of difference about the chirp, too. This rig draws not more than 2½ amperes when key is pressed and, of course, none when key is up so its average efficiency is quite high. It will handle 25 w.p.m. okay. Break-in can be worked with it also. I have my Type 45 filaments in series and heat them with five volts d.c. The 6-volt battery for the keying relay heats the rectifier tubes which are in parallel. Very likely, an excellent portable power supply could be built up like this, using No. 6 dry cells. — *Wilbur J. Tabor, W9KUI*

—···—

Transmitter Power from 32 Volts—Another Design

THE power supply being used at W8EZQ probably will be of interest to those amateurs who are handicapped by having nothing but low-voltage d.c. for power supply. It operates directly from the 32-volt Delco lighting circuit here but the same idea may be used on any d.c. supply from a single 6-volt storage battery to the 220-d.c. used in some village lighting circuits.

The rig here consists of a special home-made spark coil having two filament windings, one for the Type 80 rectifier and one for the 10 oscillator, in addition to the high-voltage winding and primary. The circuit, with the exception of the primary, is identical with the well-known a.c. rig using a half-wave rectifier and brute-force filtered system. Fullwave rectification is of course more desirable, but unfortunately the wire on hand for the h.v. secondary was not sufficient to give enough voltage each side of the center-tap. The result was the half-wave system using the two sections of secondary in series. The complete circuit of the power supply is shown in Fig. 21.

The core of the spark coil used now is made up of laminated iron and measures 1½ by 1¼ inches in cross section. The first coil tried used a soft iron wire bundle one inch in diameter. The length in both cases was 7 inches. There seems to be no advantage to the larger core; it was tried in an effort to reduce the number of turns per volt, but it was found that 10 turns per volt was the best that could be done. This gave 320 turns of No. 20 enameled wire on the primary for 32-volt operation. A smaller number of turns caused prohibitive sparking at the buzzer points. The 5-volt winding for the 80 rectifier contains 60 turns of No. 20 enameled wire; a few extra turns were added here for good measure but the voltage was not excessive. The winding for the filament of the 10 oscillator contained 90 turns of the same wire; the extra turns here made the use of a filament rheostat necessary.

The high-voltage secondary contains 2.8 lbs. of No. 28 s.c.e. wire, wound in two sections of 3450 turns each. These sections are wound in even layers with a piece of typewriter paper between each layer. Thinner paper was not used because of the trouble with the end turns of each layer.

The interrupter is the regular Ford buzzer assembly, with a toothpick under the brass reed on the stationary contact and an extra spring-steel vibrator under the regular Ford vibrator to add stiffness and increase the frequency.

The whole power supply is assembled in a wood box 10 by 10 by 6 inches. A four-wire cable about 9 feet long, carrying the 10 filament supply and the high-voltage leads, runs from the power supply to the oscillator. This power unit is then placed in the next room as far away from the operating position as possible. In this way the noise of the buzzer is scarcely audible, which is greatly appreciated by the rest of the family.

The oscillator unit is a vertical breadboard layout using the single-control transmitter circuit. The rig has been on the air every day since early February, and the log shows 40 contacts during 15 days, all on the 80-meter c.w. band. The QRI reports are two near d.c., 6 crystal p.d.c. and all the rest p.d.c. Signal strength varied from S6 to S8 with the average about S7. These contacts were all with 8th and 9th

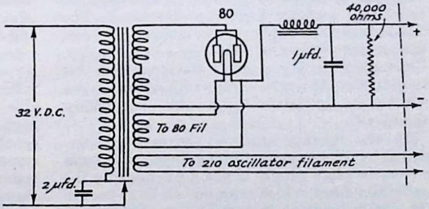


FIG. 21

district stations within a radius of about 300 miles. The plate current with antenna on is 55 mils, and with antenna off about 38 mils. The actual voltage is not known but it put the pointer off the scale on a 300-v. meter early in the experiment.

In a problem of this kind there are always detail difficulties, and I would be glad to hear about them from anyone building a similar rig. The most unsatisfactory part of the thing is the buzzer. Possibly a circuit breaker such as is used on automobiles, operated by a small motor, would do the trick. A closed-core transformer could then be used with a possible improvement in the voltage regulation and the number of turns required per volt.

This power supply seems to require less filter then the usual a.c. rig. The choke is an old make-and-break coil from a gasoline engine. Only one filter condenser is used. An 8-μfd. condenser was first tried in place of the 1 μfd. but did not improve the signal to any extent.

A word of warning may be in order against the use of a 60-cycle a.c. volt meter in checking the filament voltage. The meter I have seems to read one-half the actual voltage although it checks o.k. on a.c. broadcast sets.

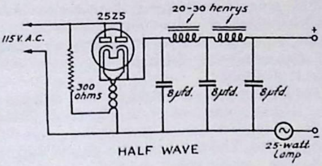
— *Lyle L. Farver, W8EZQ*

—···—

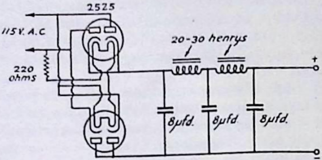
Transformerless Plate Supplies

The idea of taking the power for *receiving* tube plates direct from the power line without the intermediary services of a transformer is by no means new, but it is only recently that the practice has been at all widespread. "Transformerless" or "universal" receivers are popular in the extremely low-price class in the broadcast field, and it is for these sets that the new 25Z5 rectifier has been developed. The 25Z5 has two separate cathodes and plates — and is equipped with a relatively high-voltage heater. Consequently it is possible to do things with this tube that could not be done with previous types without an unjustifiable amount of auxiliary apparatus.

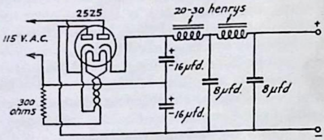
To the ordinary amateur the saving represented by the elimination of the transformer from a receiver plate supply is not great because the smoothing filter, which represents a large part of the cost, is just as necessary and must be just as elaborate, if not more so. Besides, the receiving tube filaments have to get power from somewhere, and this usually means that a transformer is needed anyhow, since serious operation of filaments from the 110-volt line is not so satisfactory with regenerative receivers. Nevertheless it is possible to make a very compact plate supply without a transformer — probably useful for a portable set, for instance. Again, a plate supply of this type can be used to replace the B batteries often used with receivers employing a.c. tubes.



HALF WAVE



FULL WAVE



VOLTAGE DOUBLING

FIG. 22

Three circuits using the 25Z5 rectifier are shown in Fig. 22. The first — and in many respects the most satisfactory of the lot — is the ordinary half-wave circuit, the plates and cathodes of the two diodes within the tube being connected together. The filter is a two-section affair, using three 8-μfd. electrolytic condensers and a pair of miniature chokes (about 50-mil. capacity). A 300-ohm resistor is connected in series with the heater of the 25Z5 to drop the voltage to 25 volts. This resistor should be capable of dissipating about 30 watts continuously. A plate supply of this type has shown itself to be capable of operating a standard three-tube regenerative receiver very satisfactorily. With the receiving-tube heaters grounded in the usual way through a center-tapped resistor, there was no noticeable hum attributable to insufficient filtering. There may be some trouble with tunable hums — a different breed of noise altogether — but these usually can be eliminated by shunting a fixed condenser of about .002-μfd. capacity across the plate and cathode of the rectifier tube, and sometimes by connecting a non-inductive .1-μfd. condenser across the 300-ohm resistor. The output voltage is about 140 with the receiver and voltage divider connected. The 25-watt lamp is in the circuit to prevent blowing of fuses should the negative side of the power supply be connected to the ungrounded side of the 110-volt line. One of the chief advantages of this half-wave circuit is that a direct ground may be used on the receiver. If the power supply is plugged in "wrong way to," the lamp will light but no damage will be done.

The full-wave circuit is shown chiefly as a matter of interest, in that it is possible to make a bridge rectifier with but two tubes. Using exactly the same filter as with the half-wave circuit, the bridge rectifier had much more hum, possibly because the predominating ripple is 120 cycles instead of 60 and a little bit of it is much more apparent to the ear. The output voltage was exactly the same as with the half-wave circuit. A direct ground cannot be used on a receiver supplied plate power from this type of circuit. The best that can be done is to ground through a mica condenser of about .002 μfd.

The voltage-doubling circuit offers about the same hum difficulties as the full-wave circuit and has the same limitation on grounding the receiver. Its principal claim to consideration is the fact that fairly high output voltage is obtainable. Actual measurement, using the same three-tube receiver as a load, showed that the output voltage was about 240 volts. The regulation will depend principally on the size of the two input condensers. Anything from 8 μfd. up seems to work well at the small load taken by the usual ham receiver.

Let us repeat once more — *do not use a direct ground on the receiver with either the second or third circuits.* One of two things is sure to result — either one rectifier will be inoperative; or, if the ungrounded side of the power line is connected to ground through the rectifier tube, the tube will be ruined. In the voltage doubling circuit there is also the possibility of blowing out one of the input condensers, to say nothing of line fuses.

— *G. G.*

—···—

Multi-Metering the Transmitter

Many of us are constantly looking for ways to get the most out of the game at the least expense. Here is one method of economizing that will detract in no way from the performance or appearance of the particular "heart's desire" we are working on at the moment. Most systems of using one or two meters to do duty in several stages have disadvantages, such as being unsightly, cumbersome, or dangerous; the method described here, however, is inexpensive and allows fast meter QSY from one stage to another.

Fig. 23 is practically self-explanatory. A 0–1 ma. meter is connected between the rotor arms of two multi-point switches, the switches being ganged together but insulated from each other. Appropriate meter shunts, indicated by S_1, S_2, etc., are left permanently across the indicated points of the two-deck multi-switch. Except when the meter is to be used for 10- or 20-mil ranges, the shunts will be of some value in the vicinity of 1 ohm or less; therefore it will be apparent that the shunts will not affect the performance of the set. In the event that a meter having a full-scale deflection of, say, 50 ma. is used in place of the indicated 0–1 milliammeter, the shunts would be of even lower ohmic resistance. In other words, use any meter at hand as long as the internal resistance is known — this in order that the external shunt may be calculated correctly. Some may say that the switch points will introduce errors, and this is true to a certain extent; however, the error is so small as to be unnoticeable for all practical purposes. Using a good meter, the error from this source will be less than is the case where many of the bargain-type meters are used without shunts. I have been using the system for some time and have tried substituting a correctly-scaled meter for the shunted one, with no difference in results.

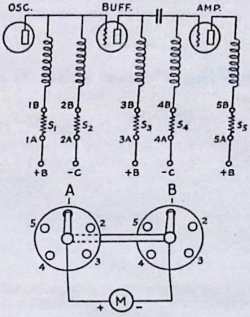


FIG. 23 — METER-SWITCHING CIRCUIT

The meter shunts are part of each circuit to which the meter is connected. The numbers on the terminals of the shunts correspond to the numbers on the two multi-point switches A and B. A suggested arrangement for a three stage transmitter is shown; the system can be used for metering more or less circuits, of course.

Editor's Note. — Two-gang multi-point switches of the type used for receiver coil switching would appear to have good enough insulation for low-power transmitters using 500 volts or less. For higher powers it would be desirable to make up special switches with plenty of insulation between contact points.

The formula for calculating the shunt resistance required is

$$R_s = \frac{R_m}{n-1}$$

where R_s is the required shunt resistance, R_m the meter resistance, and n the scale-multiplying factor desired.

It is suggested that two meters be used, each with its separate switch, in order to obtain simultaneous grid and plate readings on one stage, or plate current in one stage and grid current in another. This will facilitate neutralizing. Remember that all grid meter connections should go to one switch, and all plate connections to the other.

—*Henry T. Brummett, W6EKS*

—···—

Measuring Power with Wattmeter

THE following trick was given me by an unknown public service meter tester and I am passing it on for what value it may have.

To determine the number of watts used by any electrical device operating on the regular line, simply disconnect the other apparatus in the house on the same meter and apply the following formula to the data obtained from the watt-hour meter reading in the cellar.

$$\frac{\text{No. of turns} \times \text{“K”} \times 3600}{\text{time in seconds}} = \text{watts}$$

Simply count the number of turns of the aluminum damping disc in the meter for the length of time that it was observed. As for "K," this is the so-called "disc constant" and for Westinghouse meters it is ⅓ for 5 amp. meters, ⅔ for 10 amp. meters and 1 for the 15 amp. meters. In the other meters such as the General Electric, Duncan and Sangamo the constant is stamped on the disc. In the newer Sangamos the constant is not marked and follows the same rules as the Westinghouse. —*Maynard B. Chenoweth, W2GCC*

—···—

Eliminating Hum Modulation

MANY hams who change from battery to resistor bias find that with only the transmitter filaments on an a.c. hum is imposed on signals tuned in on the receiver. The popular "10's in push-pull" do this plenty. In one instance, a high resistance voltmeter across the plate supply read 600 volts positive when "on" and 20 volts negative when "off" the air. Being cut-and-try here, we looked for the cure first, and found that a 7½-watt lamp in series with the plate transformer primary balanced out the hum. A small "C" battery in series with the grid resistor sometimes works, too.

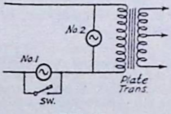


FIG. 24

Going a bit farther, the diagram of Fig. 24 shows a simple "on-off" signal device. Lamp No. 1, in series with the primary of the plate-supply transformer, shows white when the set is off the air. Lamp No. 2 comes on red with the transmitter and No. 1 goes out. Both lamps are 7½ watt. The lamps help smooth things for primary c.w. keying also. —*Harry Hurley, W6QF*

—···—

Battery Grid Bias

THERE are certain grid bias requirements, such as in Class-B audio and Class-B linear amplifiers, demanding a constant voltage which can be most satisfactorily and easily met by the use of battery bias. Batteries are also much used for biasing Class-A and Class-C amplifiers.

One difficulty often experienced with the use of bias batteries is the effect of the grid current. This current, flowing through the battery in a reverse direction, has a charging action which often results in very erratic battery voltage and short battery life. The circuit shown in Fig. 25 will correct this condition. The resistor in shunt with the bias battery eliminates the charging component by compensation. In operation, all tuning and neutralizing adjustments are made with the switch *S* open. Then, after closing the switch, the resistor *R* is adjusted so that the milliammeter reads zero.

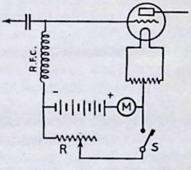


FIG. 25 — BY CHOICE OF SUITABLE RESISTANCE VALUE AT R, THIS CIRCUIT WILL ELIMINATE BIAS FLUCTUATIONS AND PREVENT DAMAGE TO BIAS BATTERIES CAUSED BY GRID-CURRENT FLOW

Under these conditions the grid bias is definitely fixed at the open-circuit voltage of the bias battery and is not subject to fluctuations because of charging. Since no current is drawn from the battery its voltage will remain constant except for the slow decline due to aging. Of course, the switch should only be closed during periods of operation.

To determine the value of resistance needed, divide the battery voltage by grid current (in amperes) and for the wattage multiply the same two factors. —*L. S. Fox, W2AHB*

Reducing Power

Two simple methods of reducing power for tuning, local work, etc., are given in Figs. 26 and 27. The arrangement of Fig. 26 is used by Harry E. Hurley, W6QF, who has found it particularly useful for those tuning operations (such as adjustment of an antenna filter) during

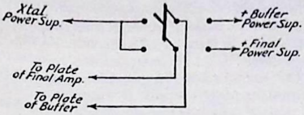


FIG. 26 — *THIS SIMPLE SWITCHING ARRANGEMENT CONNECTS THE OSCILLATOR PLATE SUPPLY TO BUFFER AND FINAL AMPLIFIER FOR TUNING OR QRP*

which the amplifier tank circuit is likely to get out of resonance. Since the crystal power supply, usually quite low voltage, is connected to all stages when the switch is thrown to the left, the off-resonance amplifier plate current is limited to a fairly low value, thus prolonging the life of the tubes.

The second circuit, in use at W4CBV, uses a s.p.d.t. switch to change a bridge rectifier to the center-tap arrangement so that either full or half voltage can be obtained. In the particular circuit shown, 83's are used in bridge with a transformer giving 550 volts each side of center tap. With the choke-input filter, the d.c. output voltage is 960 with the switch on the upper contact, and 480 with the switch on the lower contact.

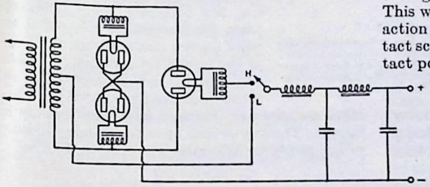


FIG. 27 — BRIDGE TO CENTER-TAP FOR VOLTAGE CHANGING

* * *

An Anti-Blinker

Here is a scheme which may help out hams who find themselves the object of their neighbors' complaints that the lights are blinking.

The transmitter at W4GQ draws quite a bit of power from the 110-volt line, as it uses a 204-A in the final stage, with a 203-A for exciting buffer, both of which stages are keyed simultaneously in the center tap. Consequently, when the key was pressed lights all along the line took a sudden dip, and the filament voltage on the transmitting tubes dropped about ten percent. It was quite impossible for anyone to read while the transmitter was being keyed because of the blinking lights, so the following scheme was adopted:

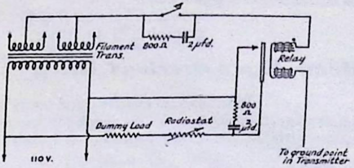


FIG. 28 — ANTI-LIGHT-BLINKING CIRCUIT FOR HIGH-POWER TRANSMITTERS

The dummy load consists of electric heater coils taking approximately the same power as the plates of the keyed tubes. The Radiostat (or heavy-duty rheostat) gives a fine adjustment of load. The 800-ohm resistors and 2-µfd. condensers prevent clicks by eliminating sparking at the key and relay contacts.

A dummy load consisting of two 660-watt electric heater coils in parallel was put in series with a Bradley Radiostat (heavy duty) and run through the contacts of a reverse-action relay. This was a 150-ohm telegraph relay with double-action armature. In telegraph use the rear contact screw has a piece of fiber in place of the contact point, and is used only for a back-stop. The contact screws were reversed, so that with the coils energized the contact was broken. Also a heavier pair of silver contacts was soldered on instead of the lighter contacts.

By reference to the diagram Fig. 28, it can be seen that when the key is pressed the d.c. in the center-tap lead actuates the relay coils, releasing the dummy load from the line. When the key is released the transmitter load goes off and the dummy load immediately takes its place. The Radiostat should be adjusted so that the filament voltmeters have the same reading when the key is down as when it is up. When so adjusted, and when the relay contact spacing and tension spring are adjusted to give quick action, there will not be time for the electric light filaments to cool perceptibly during the action of the relay. Result: No blinks, and steady transmitter filaments. When once set the unit may be forgotten. The same switch which cuts the power to the filament transformer during listening periods also disconnects the dummy load, so there is no avoidable waste of current in the dummy.

One word of warning! Don't use a relay with too high d.c. resistance, as it will introduce bias to the transmitter. The 150-ohm relay works very nicely here.

This arrangement has been in use at W4GQ for some time, and works perfectly with any power used. A broadcast receiver in the next room, approximately 15 feet from the transmitter, operates with no interference at all. The only indication that the transmitter is being operated is a dip in the lights when beginning a period of transmission and a brightening back to normal when the transmission is concluded.

—*A. H. Davis, W4GQ*

—···—

Home-Made Overload Relay

BEING of an experimental mind I am constantly making some change in my transmitter with the result that I am forever blowing fuses, so I decided to make an overload relay. Sounds simple but isn't. I found that because of the varying load caused by keying, the relay armature would not stay steady until the proper time to throw, and also that to break the high voltage was impracticable because of the long arc between the contacts. Using a 1500-volt plate supply, the contacts had to open more than an inch to make a complete break. Several systems of latches designed to hold the armature closed until an overload came on and to hold it open after the break proved unsuccessful.

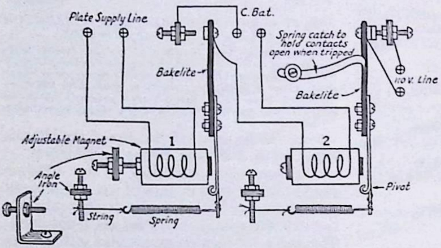


FIG. 29—HOME-MADE OVERLOAD RELAY

Relay No. 1 in series with the d.c. plate supply line, closes when the plate current passes a predetermined value. This in turn closes the circuit of relay No. 2, which breaks the 110-volt supply to the power transformer. A spring catch prevents the armature of relay No. 2 from dropping back to its original position until released by hand.

The contacts were changed to make instead of break, and in making contact energize a second relay which in turn breaks the line supply. The transmitter "C" bias batteries are used to operate the second relay. The first relay, carrying the transmitter plate current, is wound with No. 25 d.c.c. wire; the second with No. 36 enameled wire. As shown in Fig. 29, the first relay is arranged to be adjustable, varying the space between the armature and pole, to take care of different load requirements.

On test this could be adjusted to trip at any load from 150 milliamperes up. Winding with smaller wire would permit it to trip on less load.

—*N. M. Patterson, W4EG*

—···—

A simple arrangement for keeping the filaments from blinking when the transmitter is keyed is to wind a few extra turns on the core of the power transformer, if space will permit, and connect them in series with the primary of the filament transformer. Three or four turns usually is enough. The key should be in the primary circuit of the power transformer.

—*W7ASQ*

8

The Antenna System

Antenna Supports

The winter season often sees many an antenna lying on the ground because the wire contracted and snapped, or because it was forced down by heavy snow or a strong wind.

I have saved myself a lot of annoyance and trouble by stringing up my antenna as shown in Fig. 1. Of course, weights on pulleys or other superior ways of holding up an antenna are to be preferred, but most of us depend on fixed supports to hold up our antennas, and in such cases this idea may help.

We must have our antennas tight enough so as not to sway too much, and as a result it doesn't take much to snap the supporting wires. If another supporting wire (as shown) is provided to hold the antenna temporarily in place, the antenna is still operative, and when a warm day comes the broken wire can be replaced.

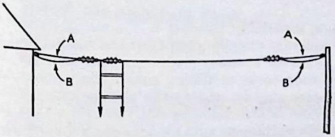


FIG. 1 — COLD-WEATHER PROTECTION FOR THE ANTENNA

The regular supporting wires are of lighter gauge than the antenna wire to ensure their breaking before the antenna itself in case of unusual strain. The extra loops will hold up the antenna until the broken wires can be replaced and normal tension restored.

— *Antonio Gelineau, W1BHR*

—···—

Guying Antenna Masts

In guying antenna masts the only possible advantage of having more than three guys to a set is that in case one of them breaks the remainder can be re-arranged to support the pole, but since any shock strong enough to cause breakage of a properly installed guy will likely bring the pole down anyway, even this advantage is doubtful. All guys of a three-guy set will always be at the same tension, just as a three-legged table never rocks.

Any intermediate guys should be arranged like the top set on the "2 by 2" mast in the *Handbook;* that is, one guy directly opposite the antenna and two front guys, all three evenly spaced 120 degrees apart. This leaves a clear space under the antenna, which is an advantage, particularly when antenna is lowered for repairs or changes.

In the case of the top guys this arrangement is not so good, because when the antenna is tightened it takes the strain off the two front guys and there is a tendency for the rig to rock sideways in a wind. It is better here to reverse the arrangement and have two back-guys, possibly somewhat less than 120 degrees apart, adjusted to pull the pole slightly back from vertical so that when antenna is pulled tight it straightens it up, the antenna and two back-guys forming a three-guy set. A top front guy directly under the antenna merely serves to keep the pole in place when antenna is down, and if intermediate guys are used and the mast is reasonably rigid this third guy will be unnecessary.

When raising a mast which is big enough to tax the facilities available, it is some advantage to know nearly exactly the length of the guys. Those on the side on which the pole is lying can then be fastened temporarily to the anchors beforehand, which assures that when the pole is finally raised the chaps on the opposite guys will pull it into a nearly vertical position with no danger of its getting out of control. The guy lengths can be figured by the right-angled triangle rule that "the sum of the squares of the two sides is equal to the square of the hypotenuse." In other words, measure the distance from the base of the pole to the anchor, square this and add it to the square of the length of the pole up to where the guy is fastened. The square root of this sum will be the length of the guy.

It is advisable to carry the pulley rope back up to the top in "endless" fashion same as a flag rope; then if antenna breaks close to the pole due to sleet storms, boys using the insulators as targets, etc., there will be no trouble in pulling down the remnants and making repairs. The writer has always used stranded clothesline wire for pulley lines rather than rope; there may be electrical disadvantages in this but it eliminates trouble due to stretching or breaking of ropes.

Care must be taken in selecting the pulleys, however, to make sure there is not enough slack between the sheave and the frame for any chance of the wire's climbing the side and jamming.

— *W. F. Reeves, VE5CT*

* * *

Twisting Heavy Guy Wires

The business of twisting guy wires on to egg and antenna insulators becomes a tedious and difficult process when the wire size is large, as in the case with some of the high masts now in vogue. A labor- and time-saving device that is as simple as it is useful can be made from a piece of heavy iron or steel with a single hole, about twice the diameter of the wire, drilled about a half-inch in from one end. The wire is passed through the insulator, given a single turn by hand, and then held with a pair of pliers at the point shown in Fig. 2. By passing the wire through the hole in the iron, and rotating the iron as shown, the wire is quickly and neatly twisted, resulting in a junction that will satisfy the most meticulous.

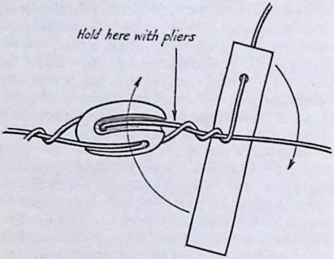


FIG. 2 — USING A SIMPLE LEVER FOR TWISTING HEAVY GUY WIRES

— *W1JPE*

* * *

Universal Joint for Zepp Antennas

The construction of a Zeppelin feeder system is, on paper, a perfectly simple matter. With a tightly stretched horizontal antenna and feeders suspended straight downwards, the antenna, the feeders and the spacers make a perfect aggregation of right angles, as may be seen from *A* of Fig. 3. The feeders do not need to run straight down; they can be displaced to either side of the antenna without disturbing the symmetry of the system. But even this ideal condition does not permit raking the feeders fore or aft along the antenna to the attitudes shown by the dotted line, in the endeavor to lead them into the shack.

In practice it is always a different matter. The antenna is never perfectly tight, the insulators always sag and the general theory goes all to pot as shown in *B* of Fig. 3. There is one attitude in which the feeders can be put and kept evenly tight — if one can find it — but as every amateur knows from bitter experience the feeders are then invariably running in the wrong direction, frequently directly away from the waiting lead-in insulators. It takes a civil engineer and all his working tools to design such a rig so that the feeders may be under even tension and yet terminate at the desired point. And even then the result will change with the tension on the antenna.

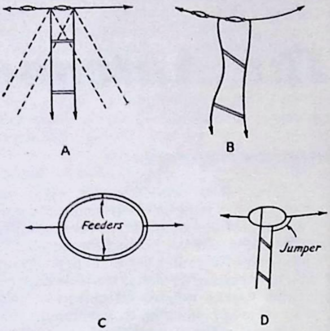
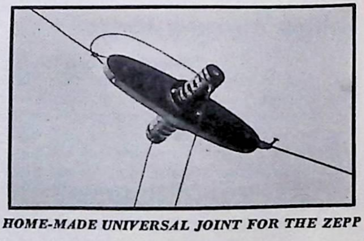


FIG. 3

Fed up with this sort of thing, I bethought me of the arrangement shown in Fig. 3-*C*. It is in effect a species of universal joint for Zepp feeders. Antenna and halyard would connect to the "ends," the feeders to the "sides," with a jumper from one side to the antenna. With such an arrangement the antenna may terminate wherever it need be and the feeders may be brought to wherever they have to go, yet remaining evenly taut. By reference to *D* of Fig. 3 it is plain that if the feeders are placed thus side by side they may



HOME-MADE UNIVERSAL JOINT FOR THE ZEPP be displaced fore or aft to any desired degree. They may similarly be displaced to either side, the entire assembly assuming a slight rotation, simply by twisting the antenna wire a few degrees. Any desired combination of the two movements is possible. You don't worry about it — you just stretch the feeders from here to there and the gadget does it.

The photograph shows an experimental insulator incorporating these ideas. A piece of half-inch hard maple thoroughly boiled in paraffin acts as the antenna insulator and carries two G.R. stand-off insulators which support the feeders. The feeders are twisted around the neck of the insulators. The planes of movement are the same as for the ellipse shown in Fig. 3.

— *K. B. Warner, W1EH*

* * *

Improving the Performance of the Voltage-Fed Hertz

RECENTLY I had some difficulty in making the usual form of voltage-fed antenna, shown in Fig. 4 A, work satisfactorily. I should like to make known a personal discovery concerning it.

The theory of operation of this circuit is based on the fact that a free oscillating tank "assumes" a ground point at the center due to the capacities of the tank to ground, provided that these capacities are equally distributed. Thus, with the center of L_1 at ground potential there is a voltage between either end of L_1 and ground. Therefore, an antenna could be voltage fed from either end of L_1. However, coupling the antenna to the tank in this manner would offset the capacities to ground, because of the ground capacity of the antenna, and thus move the "assumed" ground point nearer the end of the tank, so that the voltage feed into the antenna would be small and this method would be inefficient for coupling, as in reality is the case.

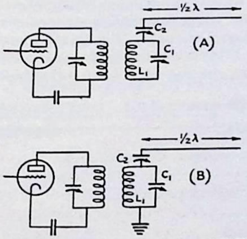


FIG. 4 — THE CONVENTIONAL METHOD OF COUPLING A SIMPLE HERTZ ANTENNA TO A COUPLING TANK (A), AND AN IMPROVED ARRANGEMENT (B) WHICH PERMITS BETTER POWER TRANSFER

The ideal condition for most efficient operation using this method would be to have the ground point and the antenna coupling point at opposite ends of the circuit, as this would give the maximum voltage feed to the antenna. The impedances would be well matched, as the impedances of both a resonant tank and an antenna at this point are extremely high. The only way possible to obtain this condition is actually to attach a ground to one end, as in Fig. 4B. The antenna now takes on the appearance of a Marconi instead of a Hertz, but it must be remembered that a resonant tank has very high impedance and high voltage instead of low impedance and low voltage, as is necessary for feeding a Marconi.

As there is practically no current flowing, no special ground is necessary, a steam radiator or a water pipe being sufficient. In tuning this arrangement, best results are obtained when L_1, very loosely coupled to the transmitter and with ground connected, is first tuned to resonance by C_1. Next, the coupling is increased until the proper load is obtained. The antenna is then connected and tuned by a series condenser or loading coil to get minimum current circulation in L_1C_1 or to get maximum current indication near the center of the antenna. It is impossible to tune by current at the end of the radiator because there is so little current that ordinary instruments cannot detect it (about 30 mils for 35 watts). It is also impossible to tune the antenna itself by the plate current of the vacuum tube, as the antenna changes affect the oscillator itself very slightly.

It is quite obvious that any current fed system, instead of being useless on even harmonics, can be made to work very efficiently as a voltage-fed antenna simply by tuning the pickup coil to resonance with the r.f. output by a parallel condenser. It is not necessary to connect a ground in this case as the capacities balance.

I experimented with this system at W1BIH's portable location in Worcester, Massachusetts, and results were all that one could wish for. Before the ground was connected, W1BIH and I called about twenty-five stations and worked only one. With the ground connected we worked an average of three out of four called, with excellent reports. Incidentally we were using a half-dead 10 at the time, and the antenna had a 90° bend near the middle.

— *C. C. Cutler, W1TX*

* * *

Remote Switch

THE drawing of Fig. 5 shows a home-made switch built by Frank Robison, W6HDX, for the purpose of changing the length of his antenna — in this particular case to change the length so the fundamental wavelength would be shifted from 40 to 80 meters and *vice versa.* A copper switch blade is pivoted as shown on a bakelite "T," the ends of the antennas being fastened at the ends of the arms of the "T." One wire is connected to the blade by a short piece of flexible wire; the other antenna connects to the switch jaw, also a piece of copper. A coil spring is fastened between the points marked *A* and *B*. A cord is fastened to the end of the switch blade so the switch can be operated from the ground. A jerk on the cord carries the blade slightly past the vertical position and the spring pulls the blade over to the opposite side, much in the manner of the small snap switches used on lighting circuits.

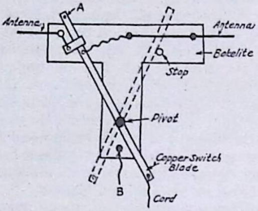


FIG. 5—A SWITCH FOR CHANGING ANTENNA LENGTH

Similar switches can also be used in other applications where the most satisfactory electrical location is mechanically inconvenient.

The uses of a switch of this type are not necessarily confined to changing the length of an antenna; for instance, for antenna changeover when the feeders are located close to a transmitter which is remotely controlled; or for operating lightning switches without opening the window, etc.

—…—

Inexpensive Feeder Separators

A few ideas for easily-made and inexpensive feeder separators are suggested in Fig. 6. The upper drawing shows the type of spreader used by Earle J. Lander, W7AHN, for which he claims the advantages of light weight, strength, and the ability to "stay put" when once installed on the feeder. It is made from five-eighths inch round celluloid rod, obtainable from small "fixit" shops at a great deal less cost than the bakelite rod often used. Holes are drilled near the ends perpendicular to the axis of the rod to pass the feeder wires, and a second pair of holes drilled in from the ends to meet the first pair. The axial holes are threaded to take whatever size machine screw is used to hold the wires tight.

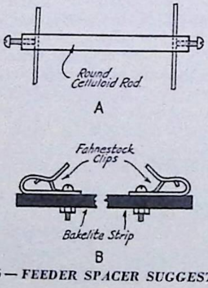


FIG. 6—FEEDER SPACER SUGGESTIONS

A second type, suggested by E. M. Gillespie, W2EAF, uses half-inch strips of appropriate length cut from junked bakelite panels, fitted out with Fahnestock clips at each end as shown in the lower drawing. This type will stay in place without special fastening, and can be readily slipped along the feeder wires if it should be necessary. J. B. Abernathy, W6FII, uses the Fahnestock clip idea with spreaders made from half-inch dowels boiled in paraffin.

—…—

Voltage-Fed Antenna with Twisted-Pair Feeders

The antenna feed system of Fig. 7 is suggested by Thomas J. Campbell, W8IEH, for combining a voltage-fed antenna with the twisted-pair type of feeder so that the antenna can be worked on even harmonics, which cannot be done efficiently when the antenna is center-fed in the conventional manner. The method requires attaching a tank circuit, tuned to the transmitter frequency, to one end of the antenna. Although this may be inconvenient in a great many cases, since the antenna tank circuit has to be retuned each time the transmitter is shifted to a different band, nevertheless the idea can be applied with benefit when the operator is confronted by an antenna problem similar to that at W8IEH. In

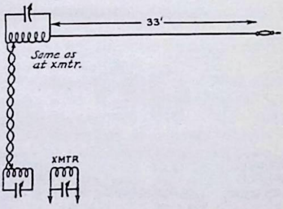


FIG. 7—TWISTED-PAIR TRANSMISSION LINE COUPLED TO A VOLTAGE-FED ANTENNA

The arrangement is useful when one end of the antenna is accessible but is not brought into the operating room itself. The twisted line may be any convenient length; when the system is properly adjusted the line losses will be small in lengths up to 100 feet or so.

Campbell's case the construction of an outdoor antenna was not feasible, and the only location which offered reasonable clearance between the antenna and nearby power wires was the attic. Furthermore, it was undesirable to install the transmitter itself in the attic because of the temperature extremes characteristic of attics. Tuned feeders were considered impractical because part of the path they would have to follow in going from the transmitting room to the attic involved rather close association with water and heating pipes. The twisted-pair feeders are unobtrusive and require very little space.

Operating the system requires tuning the coupling tank circuit to the same frequency as the transmitter, adjusting the number of turns across which the feed line is connected, and making similar adjustments at the antenna tank circuit. W8IEH did all his tuning with only a neon lamp, the object of adjustment being to get maximum glow when the lamp was touched to the end of the antenna. The adjusting procedure can be simplified somewhat by omitting the coupling tank at the transmitter and connecting the feeders directly to the transmitter tank circuit through insulating condensers of about 0.002 μfd.

The antenna should be cut for the lowest-frequency band on which operation is desired. The 33-foot antenna at W8IEH was all the attic length would permit, and the system is therefore best at 14 Mc. and higher frequencies. It has been successfully operated on 7 Mc., however, the antenna tank circuit acting as end loading to lower the frequency of the system.

—····—

The Twisted-Pair-Feeder Transmitting Antenna for Receiving

The following might be of interest to those amateurs who use a low-impedance twisted-pair line for the transmitting antenna, and who would like to use this antenna for reception without the customary changeover switch or relay.

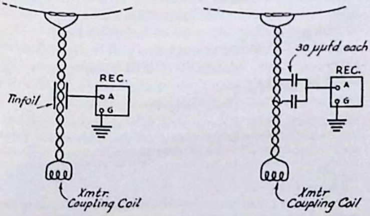


FIG. 8 — USING THE TWISTED-PAIR-FEEDER TRANSMITTING ANTENNA FOR SIMULTANEOUS TRANSMISSION AND RECEPTION

A piece of tinfoil or leadfoil about six inches long is wrapped around the lead-in, as shown in Fig. 8, and the antenna post of the receiver connected to it. The ground post of the receiver is connected to ground. The antenna now works as a "T" type for receiving because of the relatively high capacity between the lead-in wires but is unaffected for transmitting. The receiver antenna coupling coil or condenser, together with this coupling device, comprises a balanced high-impedance circuit bridging the low-impedance feeder, and does not absorb a measurable amount of power.

Two equal small capacities of about 30 μμfd. could be used, but most hams probably will want to use tinfoil or leadfoil because it costs nothing.

— *M. W. Rife, W9IWV*

—····—

Half-Wave Hertz for Receiving

The selectivity and signal-to-noise ratio of the National SW3 has been greatly improved by coupling a half-wave Hertz antenna inductively as shown in Fig. 9.

The additional control, C_1, is not critical. The receiver remains "single control" over ranges of 40 to 60 kc. An optimum and critical value of coupling exists between L_1 and L_2. When the coupling is properly adjusted, variation of C_1 effectively discriminates between signals which would ordinarily interfere, and such tuning affects the signal strength alone and not the frequency of the beat note.

This attachment has proven very satisfactory during the past two months. There is no reason why it should not operate equally well at other frequencies when the aerial is cut to a length calculated to develop a voltage loop at the end connected to L_1. — *Robert A. Gallery, W3CTQ*

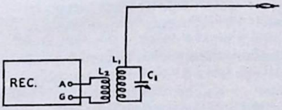


FIG. 9 — TUNED ANTENNA TO IMPROVE REGENERATIVE RECEIVER PERFORMANCE

The specifications given below apply to the 7-Mc. band. The antenna should be approximately 66 feet long.

C_1 — 90-μμfd. variable condenser.
L_1 — 21 turns No. 22 enamelled wire on 1½-inch diameter form. Turns should be spaced to make length of winding one inch.
L_2 — 10 turns No. 22 enamelled wire, close wound.

Editor's Note: The chief requirement of the circuit L_1C_1 is that it should be capable of tuning over the band to which the receiver is set. It is therefore an easy matter to apply the method to bands other than 7 Mc. The antenna will work well on harmonics; it may, in fact, be made approximately 130 feet long and will be suitable for 3.5 Mc. and all higher-frequency bands.

—···—

Kink for Using Single-Wire End-Fed Antennas

Here's a tip from Bill Reeder, W2HLX, which may help some of those hams having trouble with end-fed antennas when coupling to the final tank is through an additional tuned circuit. He says:

"In using the end-fed single-wire antenna system I find that the set-up does not always function properly. A parallel tuned coil and condenser circuit will load up an r.f. amplifier regardless of whether an antenna is coupled to it or not. I have found that sometimes although my antenna tuning circuit loaded the r.f. amplifier very nicely, very little r.f. energy was getting into the antenna. This trouble was due to incorrect length of the antenna proper and was cured as follows: Another wire, the length of which must be determined by the cut and try method, is connected to the opposite side of the antenna tuning circuit, as shown in Fig. 10. The length of this wire is adjusted until an equal amount of r.f. voltage, as judged by a neon bulb, is present at both ends of the antenna coil. Often if the antenna is not the right length exactly all the r.f. voltage tends to be at the end of the antenna coil opposite from the antenna.

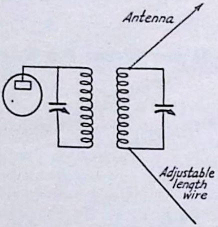


FIG. 10 — COMPENSATING FOR WRONG ANTENNA LENGTH IN THE END-FED ANTENNA SYSTEM

"One very useful application of this arrangement is when a station has several different frequencies. In this case a number of single-pole switches can be inserted in the wire for adjusting the length to suit the frequency."

—···—

Some Zepp Pointers

It is surprising how few amateurs are using the once popular Zepp antenna since the advent of crystal control. Many amateurs contend that this type of antenna will not couple tightly enough to draw sufficient power from their amplifiers and so they use single-wire matched impedance antennas which are difficult to get working properly. I believe the following dope will help these men to build a Zepp which will outperform most "yard-stick tuned" single-wire affairs.

To begin with, the multiple 1.56 times the wavelength in meters is a little short — so short, in fact, that an antenna so designed will fall too far above the crystal frequency to resonate properly.[1] The multiple used here is 1.59 and thus a 65-foot flat-top will tune to 7228 kc. and a 66.5-foot one to 7185. This is proven by tuning a self-excited oscillator to the antenna and measuring the frequency.

A Zepp is a one-frequency affair. No amount of juggling a feeder series condenser will affect the length of the flat-top. Therefore we can cut the feeders to half the length of the flat-top minus the number of feet of wire in the antenna coil. Thus an antenna 66 feet long with 3 feet of wire in the antenna coil will use feeders 31.5 feet long. This eliminates the series condensers.

Most manufactured feeder spreaders are too short. Sterling's Manual is my authority for using 1/200th wave spacing or 7 inches for the 40-meter band.[2] The simplest low-loss spacers may be made by using a hard rubber dowel 8 inches long with hack-saw cuts in the ends and machine screws passed through to tighten them to the wires. The rods come in two-foot lengths and a pair of these will make six spacers, which is enough for quarter-wave feeders at 40 meters.

No. 14 wire is the easiest to work and will carry all the antenna power an amateur may legally use. Paraffin-impregnated wood is not recommended for spreaders because in my experience they leak in damp weather and throw the system out of tune.

To make the system even more low loss the antenna insulator is slipped along the flat-top to the proper spot and the wire twisted around the insulator and brought down as a feeder. This does away with a soldered connection and the antenna is one piece from skywire to antenna coil!

It is well to remember that a half-wave antenna radiates best broadside. This effect may be marked, and on a low-power rig here it meant the difference between working Africa, Hong Kong and Japan with a north and south antenna and merely Australia with the same antenna pointed east and west.

---

[1] In many cases the opposite has been found to be true the factor 1.56 giving an antenna length slightly too great for the frequency. The length for a given frequency will vary somewhat with local conditions; if the antenna is to be adjusted exactly to frequency a little cut and try is called for. — Editor.

[2] The closer the wires the better the cancellation of the fields about them, hence the requirement that the spacing should be small compared to the wavelength. Since the capacity between wires increases as the spacing is reduced, closely-spaced feeders will show larger currents for a given amount of power, which tends to increase the ohmic losses slightly. Neither factor is of great importance in the ordinary amateur tuned feed line, however, customary practice being a fair compromise. — Editor.

Many of these Zepps are in use around Los Angeles with consistently good results. Accuracy in measuring the wire and care to keep the antenna far enough from tin roofs to prevent absorption are the main considerations. Also it is poor practice to use a No. 10 flat-top and No. 16 feeders. No. 14 is cheap now and four bits or so is a good investment in the most important part of your station.

—···—

An Unorthodox Antenna

Many antenna systems, though theoretically good radiators, have the weakness of radiating at angles often not effective for communication. In addition, theory cannot provide sufficiently for the presence of objects such as metal roofs, gutter pipes, BCL antennas and the like, which usually exist on the premises of most amateurs. Hence an antenna which is designed from experiment rather than theory would seem to be justified.

Such an antenna has been designed by the writer's friend, Mr. H. J. Siegel, W3EDP. On first coming on the air two years ago, though he consumed over a thousand feet of wire in experimenting with antennas of the usual types, W3EDP failed to get satisfactory results. His goal was an antenna which could be operated efficiently on all bands, so he set about to design a new antenna, trying to find the best compromise between radiating angle and theoretical efficiency. The radiating angle of an antenna depends not only on the height above ground and the orientation with respect to the horizontal but also on the length. Being unable to alter the first two factors, W3EDP varied the third.

A one-hundred-foot roll of wire was hung up to his mast and tried out for several weeks on 7 Mc. The results were carefully tabulated, with due allowance being made for adverse conditions. Four feet of wire was then cut off and this process repeated. Almost every reasonable antenna length was tried, and then the entire process was repeated several times. When all the tabulations were complete, a length of 84 feet seemed to stand out as being the best of all the combinations tried. It may be apropos here to state that the antenna in all cases was inductively coupled to the final power amplifier by a parallel-tuned tank circuit on all bands. This parallel-tuned circuit was arranged for variable coupling to the final power amplifier tank coil so that it could be adjusted for maximum efficiency and so that the load on the final amplifier could be controlled. It is important to mention here that low *C* in the antenna circuit gave by far the best efficiency. High *C* caused a high circulating current and looked very nice on the thermocouple ammeter but was nil for results.

Not liking entirely the idea of an end-fed single wire antenna, W3EDP set about to find a counterpoise for the best results with his 84-foot antenna. Going through a pruning process similar to that with the antenna itself produced a counterpoise length of 17 feet as the one working best in combination with the antenna. This combination seemed to work excellently on 160, 80, 40 and 10 meters, but on 20 meters a counterpoise length of 6½ feet seemed to outshine all others. The parallel tuning arrangement remains untouched for operation on all bands. W3EDP was a bit skeptical about the operation of this system on 10 meters, so he put his transmitter down there to find out. Results were about equal operating with the 17-foot counterpoise and in operating without any counterpoise at all. The antenna is about 20 feet from the ground and the counterpoises are strung in the room near the ceiling of the first floor of his house. No lead-in arrangement was found necessary, the antenna and counterpoise both being brought directly to the antenna coil. The antenna and counterpoise are at right angles to each other.

Like most antennas, this one has its directional properties, though it is a bit difficult to say just what they are, for at most times it gives excellent results in all directions. Recently we have been getting VK, ZL and ZS stations twice daily on 14 Mc., apparently by different paths; VK and ZL have been worked in the early and late mornings, early afternoon and evening and again at midnight; ZS stations at early afternoon and again just before midnight. Roughly speaking, the antenna seems to give best results in a direction at right angles to its length. It also has the unusual property of emitting a very weak ground wave. On 7 Mc. W3EDP's signals have been barely audible across town, when at the same time he was QSO the west coast and getting an S8-9 report.

Though this antenna may seem unorthodox to many, the results obtained with it should justify it fully. Using a pair of 46's with 50 watts input to the final P.A., W3EDP has consistently received S7-8 reports on 7 and 14 Mc. from five continents. In addition he has worked 75 countries in all continents within two years with this little rig from an average DX location, a record not duplicated by many using higher power. W3EDP has used his antenna system at two different locations with equal results. In addition the writer has used this antenna in a badly screened location, between two houses and under several trees, yet without altering the dimensions from those given him by W3EDP he has obtained excellent results on 3.5 Mc., having worked Europe several times with a pair of '10's.

This antenna is not offered to the reader as a cure-all for his antenna troubles. To discover its true value it will have to be tested at more locations of different characteristics. The dimensions may have to be altered slightly in some locations for maximum efficiency. It is the writer's belief that the design of this antenna perhaps may be the basis of further antenna experiments.

—*Yardley Beers, W3AWH*

—····—

A Sleet Melting Antenna

NEARLY every winter we have sleet storms in this section and many transmitting antennas are broken down by the weight of the ice or rendered useless by excessive losses and the detuning effect of the ice.

Several years ago it occurred to me that the most dependable type of antenna would be the feederless end-fed type since the total weight and exposed insulation is much less than with other types. However, the detuning effect of sleet is still serious, and in an effort to correct this condition, a scheme of sleet melting by means of a 60-cycle circulating current was devised and installed this Fall.

The antenna consists of two parallel wires, closed at the far end and separated about one inch by spacers inserted every four feet. These spacers are one-inch square blocks of soft wood fastened in place by binding with fish line. The transmitter end is attached to a d.p.d.t. switch so that the antenna may be switched quickly to the heating transformer. A quick changeover is desirable as it may be necessary to apply heat during listening periods to prevent the sleet from sticking.

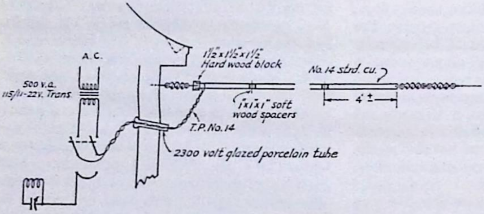


FIG. 11—SLEET-MELTING SYSTEM FOR AN END-FED ANTENNA

From experience with melting sleet on power lines, I calculate that 230 to 400 watts will produce adequate melting at 0° F. for a 130-foot No. 14 wire antenna. The current is supplied by a 500-va., 115/11-22-volt sign lighting transformer. These transformers are comparatively easy to obtain around repair shops as many incandescent signs that once used them have now been replaced with neon signs.

With the end-fed antenna, better efficiency is realized by using a high-L in the antenna tank. The coil here for 80 meters is 19 turns of No. 14 d.c.c., 3½ inches in diameter. The tuning condenser is a 7500-volt, 30-$\mu\mu$fd. size.

Even if you prefer some other type antenna for regular use, this type would be worth while as a stand-by for emergency use. It is well to remember that during sleet storms, amateurs are often called on to supply emergency communication.

—*Chas. W. Carter, W3EZL*

—····—

Antenna Pruning for Efficiency

IN CONNECTION with end-fed antennas, James A. O'Neil, W6GIS, has some good suggestions on the business of getting the proper antenna length. His letter is quoted below:

"The method we use is to cut the antenna over-long and then clip to the final tank circuit, which of course is tuned to resonance, selecting a point where plate current is near the desired amount. It then becomes necessary to retune the final to lesser capacity for minimum plate current.

"Disconnecting the antenna, six inches or a foot is cut off, the final retuned to resonance, and the antenna put back on. The change in capacity for the low point in plate current will be less. This process is repeated several times until a length of wire is obtained which requires no retuning of the plate circuit; resonance has then been obtained. It is quite an accurate indication of exact length because as the antenna resonant frequency is approached the pruning must be done in inches. Should too much be removed, the plate tank again requires retuning, the capacity now being increased. With ordinary No. 12 copper this presents no problem. A strong tug restores the needed inches.

"The foregoing, of course, only applies to transmitters which are not self-excited. Adjustment of such may be achieved without much more trouble. The receiver, monitor, frequency meter, or what have you, should be set to the portion of the band where operation is desired and the transmitter tuned to zero beat with the antenna disconnected. Tapping on the over-long antenna will drive the transmitter off the selected frequency and necessitate retuning of the transmitter and checking device for zero beat. Cut and again cut till the transmitter frequency remains constant unloaded or loaded.

"In either case the antenna resonant frequency perfectly corresponds to that of the transmitter and the radiating system acts as a resistor load. A good match can be expected over the whole band, usually better than the average hit and miss installation.

"Clipping onto the plate coil for coupling is the ultimate in simplicity, particularly if a split-stator is used for harmonic suppression, but unfortunately is not lawful. The next best thing is the antenna filter described by Collins, which also discriminates against harmonics, and furthermore gives a perfect match on any part of any band if frequency shift is desirable.

"Surely someone will say: why cut to the inch, when copper will stretch a foot or more under strain and any difference can be compensated for in the coupler? The first answer is copper-weld cut to the frequency most in use, or else a periodic trimming of the wire. Secondly the antenna filter is fine and dandy for moving hither and yon, but, for the main frequency, it is my personal opinion that the antenna should be a straight stretch of wire without a loading device. Particularly so when low power is used and every watt is wanted where it belongs.

"The preceding remarks apply mainly to the end-fed antenna since it enters directly into the shack. It is advisable to place the set as close as possible to the entrance for obvious reasons, which brings up the question of loss of height and absorption. Theoretically, they both tend to lower radiation efficiency. But actual results — and after all that is what the majority strive for, whether by orthodox means or not — proved the end-fed superior to a Zepp and single-wire feed system in the same direction at a greater height. Better transfer of energy from the transmitter to the antenna proper helps account for it, and in addition, the usual end-fed has one end considerably lower than the other with resultant directivity off the low end which is absent in the horizontal type.

"To sum up —

"1. The end-fed is the essence of simplicity, requiring no feeder arrangement.

"2. The correct length is easily obtained using only the plate meter.

"3. There is no need to worry whether the power entering the feeder or feeders is being transferred efficiently.

"As a specific instance, an ordinary Zepp caused a 203-A to color slightly at 200 watts input while an end-fed allowed the same tube to be run cold at 350 watts.

"In conclusion, no matter what type of antenna or feed is used the results obtained from careful adjustment are well worth the trouble, since, as K. B. Warner pointed out, the antenna is the weak link in the set-up."

—···—

Adjustable-Length Antenna

With the increasing popularity of the vertical antenna for the higher frequencies, many amateurs will be interested in a method for adjusting the length to match the transmitter frequency. A scheme used by Keith Russell, VE9AL, makes it possible to adjust the antenna length quite accurately without cutting. He writes: "I have . . . noticed that a large number of amateurs are coming around to the use of 20-meter half-wave vertical doublets, usually fed by a twisted wire pair. The antenna I am using is of this type, fed with a twisted pair. My frequency is 14,112 kc. so it worked out that each half of the doublet was approximately 16 feet 6 inches in length theoretically. It is well known, however, that contiguous objects such as poles, other wires, etc. have an effect on the natural period of the antenna, and my job was to figure out how to compensate for any such discrepancies with a minimum of exertion to myself. I think I have succeeded in doing this by a device which others might care to copy, as it is so relatively simple.

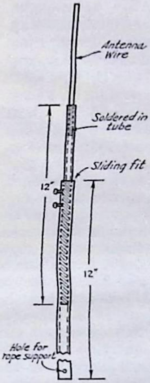


FIG. 12

"I went to the local hardware store and bought two feet each of two brass tubes, the smaller of which made a nice sliding fit into the larger tube. The larger tube has a fairly thick wall, so that it will readily hold a tapped hole and screw. I sawed the two rods both in half, making them exactly one foot in length. I then drilled and countersunk a fairly good-sized hole in one end of each of the large tubes, for attaching the rope or other insulating device. Near the other end two holes were drilled and tapped for 8/32 machine screws. The small tubes were then laid down alongside a steel rule, and with a triangular file nicks were cut every half inch. The two antenna wires were then cut 1 foot 5 inches shorter than the theoretically correct length and one soldered into one end of each of the smaller tubes to a depth of one inch. A small tube was then inserted into each large tube, and using the nicks as a guide, were pushed in and locked tight with the set screws to form one solid piece. The aerial was then pulled up and feeders coupled very loosely to the transmitter and a plate current reading taken. Then the antenna was lowered away and the inside tubes at each end of the antenna slid either in or out some four inches, the antenna pulled up and the reading taken again. Considerable change will be noticed in the plate current of the transmitter, indicating whether the frequency of the transmitter is getting more closely into resonance with the antenna, or farther away. Corresponding adjustments back and forward will enable a very close match to be made between the antenna length and the frequency of the transmitter. The cut marks in the small tubes enable the adjustments to be made identically at both sides of the antenna to one-half inch.

"This scheme avoids the necessity for clipping off portions of the antenna with a pair of pliers and then finding that you have taken off too much."

—…—

Changing the Antenna Directional Characteristics

It is not generally realized that some change in the directional properties of a center-fed full-wave antenna can be brought about by changing the feed method. Quoting from a letter from Edward W. Sanders, W3AKU, "In *QST* several articles have appeared in which mention has been made of the use of an antenna system having two half-waves in phase on the flat-top. Such a situation results in an antenna directional at right angles to the axis of the flat-top, and is accomplished by the use of a full-wave flat-top with an odd quarter-wave feeder connected in to the center. If we increase the length of the feeder by one-quarter wave by means of loading coils or by switching in the appropriate length of wire, we will have two half-waves on the flat-top, but they will be out of phase, corresponding to an end-fed full-wave antenna. This system will produce a four-lobed characteristic, as shown in Fig. 13."

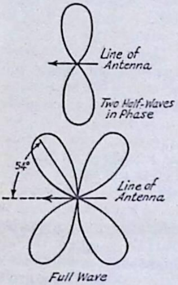


FIG. 13—HORIZONTAL-PLANE DIRECTIONAL CHARACTERISTICS OF TWO-HALF-WAVES IN PHASE (UPPER) AND FULL-WAVE (LOWER) ANTENNAS

The reversal of phase in one half-wave section of the antenna can be brought about in a number of ways. A section of wire measuring a half wave can be inserted in *one* feeder, or a loading coil having the same equivalent length can be substituted for the half-wave section. A third method is shown in the lower left drawing of Fig. 14. In this case the two quarter-wave feeders are simply connected together and the whole system worked against ground. A short ground lead is necessary in this case. In all three of these methods the feeders are no longer non-radiating, but become a part of the antenna.

To have the feeders non-radiating with either method of antenna phasing, it is necessary to use a third feeder wire which can be appropriately connected to the other two. The two right-hand drawings in Fig. 14 illustrate the method of connection. The upper drawing corresponds to the usual method, giving the directional characteristic of the upper drawing of Fig. 13. The lower drawing puts the two half-wave sections out of phase, giving the directional characteristic of the lower drawing of Fig. 13. This corresponds to feeding two half-wave antennas from a Zepp feeder. The change can be made quite simply and quickly by installing a switch to shift one of the active feeders from one side of the coupling apparatus to the other.

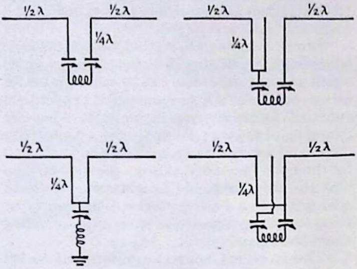


FIG. 14—FEEDER-CHANGING METHODS TO ALTER THE DIRECTIONAL PATTERN TO CORRESPOND TO THE DIAGRAMS OF FIG. 13

The two upper drawings will give a pattern like the upper drawing of Fig. 13. The lower drawings give the lower pattern of Fig. 13.

—…—

Antenna Directivity

The following letter from W. W. Smith, W1HIO, describes his experiments along the line of obtaining antenna directivity. Undoubtedly it will be of interest to fellows who want to do some work of this type and have the necessary space:

"I have erected and tuned a matched-impedance Zeppelin antenna similar to the one described by L. L. Hardin in February, 1935, *QST*. It is unnecessary, however, to cut the flat top and insert a meter or lamp for tuning. I used a low-resistance lamp bulb in the center of the shorting bar, a scheme which gives good results since the shorting bar is at a current antinode when properly adjusted. On high power a small shunt could be placed around the meter or lamp bulb. After the adjustments are completed the shorting bar with the lamp in it can be replaced with a solid wire soldered to the feeders.

"After using the half-wave Zeppelin for a while I began to wonder how I could improve it. I then decided to add another half-wave section on the dead ended feeder and operate both flat tops in phase. This made the antenna slightly directional and improved reports from stations at right angles to the flat top. After using it this way for a while I wanted more directional effect, so made up another quarter-wave feeder with shorting bar and another half-wave flat top and added that to one end of the antenna. This narrowed the beam of radiation to about a 45-degree arc at right angles to the flat top, and we started getting S9 plus reports with only 50 watts input to a pair of 46's. The second quarter wave feeder is tuned with a shorting bar with lamp bulb in series with it, the bar being slid up and down until the point of maximum brilliancy is found just the same as on the first feeder.

"To date I have operated four half waves in phase for a flat top, and it gives better results than any beam idea I have tried. Some day I am going to make a reflector just like the antenna and place it a quarter wave behind the flat top for still more gain. This will make it a one-direction radiator of a shape more suitable for my location than a 'V' type antenna."

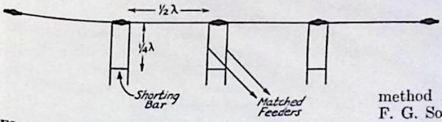


FIG. 15 — A DIRECTIVE ANTENNA CONSISTING OF FOUR HALF-WAVE ANTENNAS FED IN PHASE

Quarter-wave phase-transposing sections are used between the individual antennas, the correct length being found by adjustment of the shorting bar. An antenna of this type radiates best in the direction at right angles to the line of the antennas.

Changing Antenna Directivity

Several times in the past I have noted in *QST* various methods of switching a full-wave center-fed antenna so as to change the directional properties by feeding the two sections of the antenna so that they are either in or out of phase. W3AKU gave some very good connections for accomplishing this (see opposite page); however, they have their objections in that with one system the feeders radiate and with the other three feed wires are required.

For several months I have been using at W5EBP on the 20-meter band a system of feeding the two ends of the antenna out of phase, without radiation from the feeders, with series tuning at the transmitter, and with two feed wires. The arrangement is shown in Fig. 16. Although I do not switch from in- to out-of-phase, this could be done very simply with a pull-cord switch at the junction of the feeders and the antenna.

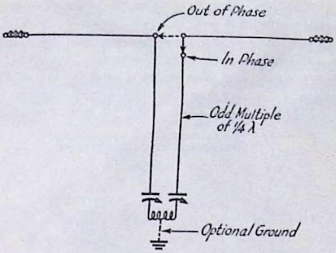


FIG. 16 — SUGGESTED SWITCHING ARRANGEMENT FOR CHANGING ANTENNA RADIATION PATTERN

— *M. H. Lovelady, W5EBP*

Antenna-Rotating Device

The essentials of an electrical method for rotating a beam antenna used by F. G. Southworth, W5EOW, are shown in Fig. 17. Rotation is in sixteen steps, which is more than sufficiently fine in graduation to utilize fully the directional properties of a simple beam antenna. W5EOW writes:

"The antenna is copied after Mims' at Texarkana *à la* December 1935 *QST*. However, it was impossible for me to rotate the antenna from the operating table by mechanical means, therefore the birth of the attached brainstorm.

"Briefly, the antenna is turned by an electric fan motor in one direction only through a 250 to 1 pinion and gear combination. Mounted on the antenna drive shaft is a rotary switch with 16 contacts. One of these contacts points directly north. The selector bar strikes one contact at a time.

"Now on the operating table there is also a 16-contact switch, each contact being labeled a direction; i.e., *N*, *NNE*, *NE*, *ENE*, *E*, etc. On this switch there are 15 selector bars, closing all but one contact at each setting. Mounted alongside this switch is a red pilot light. The hookup is simple; the contact on the switch at the antenna end which points directly north is connected to the contact on the operating table switch tap marked *N* and so on through all sixteen contacts. One side of the motor is wired to 110 volts and the other side to the center contact on the antenna switch. The other side of the 110-volt line goes to the selector on the operating table switch. The pilot light is wired in parallel with the motor.

"The operation is simple. Set the operating table switch for any desired direction, which is the direction of the open contact. The pilot light immediately goes on and the motor slowly turns the antenna and the selector switch. When the selector bar reaches the tap corresponding in direction to the open tap on the operating switch, the power is broken and due to the pinion drive the antenna immediately ceases turning. The pilot light also is doused, informing the operator that the antenna is correctly pointed."

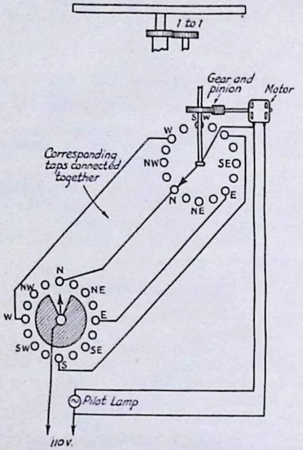


FIG. 17 — AN ELECTRICAL METHOD FOR ROTATING A BEAM ANTENNA

It utilizes a small motor with a pair of sixteen-contact switches, the antenna automatically moving to the direction at which the operating-table switch is set.

—…—

Tuning the Receiving Antenna

Most of the modern receivers have so much sensitivity that we don't worry about an antenna, but just hang any old wire on the antenna post and forget it. Some of us, of course, use a doublet with a low-impedance line for receiving, and, finding that it also works well on bands other than that for which it was cut, forget about the probable poor transfer efficiency.

Many of the latest type superheterodyne receivers are equipped for low-impedance input, and are working quite efficiently when a doublet is used on its fundamental frequency. A worthwhile improvement can result, however, by matching things up a little better on the harmonics. Then, too, there is the case of the fellow who wants to use his transmitting Zepp or single-wire-fed Hertz for receiving also. He runs a wire over to the receiver and opens it with a switch when the transmitter is running. But he probably does not get maximum signal transfer, merely an improvement because the transmitting antenna was given first choice of location.

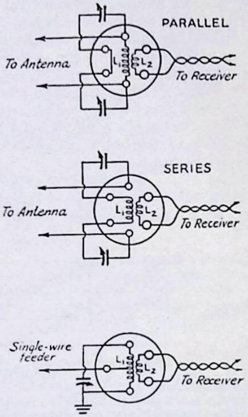


FIG. 18 — TUNED COUPLING CIRCUITS FOR THE RECEIVER

Connects to standard 5- and 6-prong coil forms are indicated. In general, inductances must be adjusted by experiment for optimum results. In the parallel-tuned circuits, L_1 should be of sufficient inductance to resonate on the desired band in conjunction with C_1 (100 μμfd.). With series tuning, the number of turns required on L_1 probably will be small. L_2, the link coupling coil, should have from two to five turns, depending upon the band and the input circuit of the particular receiver used.

A suggestion that works is shown in the sketch, Fig. 18. It merely consists of a tuning system, readily adaptable to the type antenna being used, coupled to the receiver through a low-impedance line. Provision is made so that by plugging in the proper coil either series or parallel tuning may be used. In the case of a single-wire-fed Hertz, no provision for series tuning is necessary.

To prevent the tubes in the receiver from burning up when the transmitter is running (high grid currents can be drawn even though the plate voltage is off) provision can be made for shorting the input of the receiver. The transmitting antenna, if used for receiving, should be switched from the coupler to the transmitter. The switching can of course be done by relays, greatly simplifying changeover.

— Byron Goodman, W1JPE

A Three-Feeder Double-Antenna System

We know that a single-wire half-wave antenna radiates best at right angles to its axis if it is in free space. It never is, but we'll get to that later. Now, supposing we put up two half-wave radiators at 90° from each other, not connected but fed separately. Then let's put the two together with one common feeder and another for each antenna, making three feeders in all, rigging a switch to select either radiator alone or both together, as shown in Fig. 19. This means we can select either a north-south, east-west or northwest-southeast directioned antenna.

I constructed an antenna like this and am more than pleased with the results. The switch was made with five stand-off insulators and two pieces of copper tubing, as sketched in Fig. 20. Three insulators are spaced five inches apart, with the two that support the two blades of the switch between them. The mechanical construction is only important in so far as the feeders should be kept apart to prevent the inactive wire from increasing the capacity between the other two. The three feeders should be exactly the same length, and should be spaced to form an equilateral triangle so that all three are equidistant. This is important, because it will be necessary to retune when switching from one antenna to another if the system is not perfectly balanced.

If an impedance-matching filter system is used for tuning, the feeders can be less critically cut in length (so long as they are equal), and the difference made up in the filter. One thing might be said, however, about the filter system. If the feeders are of such a length as to bring a current loop at the first condenser, adjusting this condenser often accomplishes little or nothing and is probably the reason why a number of amateurs have condemned the otherwise popular "pi" system. If you run into this condition, adjust the loading coils until the second condenser, when set at resonance, causes the proper plate current to flow in the final stage.

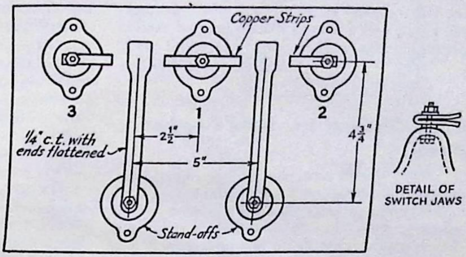


FIG. 20 — FEEDER SWITCH CONSTRUCTION

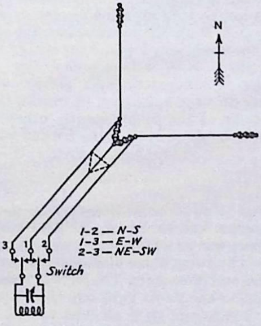


FIG. 19 — THE DOUBLE ANTENNA WITH ITS THREE FEEDERS

The switch permits selecting either antenna or using both at once for different directional effects.

As mentioned before, the action and influence of surrounding objects affect the antenna appreciably. For this reason the feeders should be tuned without the antennas connected, but pulled up in their final positions. Reduced voltage should be used during this testing. Note the dial reading of the antenna tuning condenser at resonance and attach one antenna. If a readjustment of the condenser is necessary with the antenna connected, the antenna is too long or too short. If the capacity has to be increased, the antenna is too short, and vice-versa. The best way is to make the wire a little too long in the first place; then prune until the length is right. Now attach the other antenna and with the switch in this position, proceed as before. After both aerials have been adjusted you are ready to load your final and CQ.

Something should be said about what to expect. With either antenna connected singly, the other is almost ineffective. However, there do seem to be some reflecting properties because my signal strength, judging by reports from those contacted, seems to have increased in all directions. With the switch in the 3-2 position there may be an increase in plate current, the reason possibly being that the inactive feeder is acting as a shield, or perhaps because of a reduction in impedance as a result of feeding two antennas instead of one. As to results, in every contact an increase of at least one "S" point was noted.

As a further suggestion, current fed systems could be tried, crossing at the center. However, I am inclined to believe that the feeder and one antenna right in the center of radiation might cause complications. For ultra-high-frequencies, reflectors might be added fore and aft of the system. Combined horizontal and vertical polarization can be used for a switch from high- to low-angle radiation or both.

The three-feeder double antenna system has more than proved effective in the seven-megacycle band, and I should like to hear of results from others who try it in this or any other band.

—J. A. Pool, W8ZZ

—···—

Hard-Drawn vs. Soft Copper Wire

When we recently considered putting up a 160-meter fundamental antenna, we ordered some antenna wire and were shipped, by mistake, some No. 12 enameled magnet wire. The question arose as to the stretch and final strength of this No. 14 magnet wire. A very simple tensile testing apparatus was rigged up and several samples tested, with data being recorded as to the increase in length up to the breaking point. The results of tests on a number of samples showed the wire to have an ultimate strength of approximately 150 lbs., and the amazing property of stretching, before breaking, to the extent of 1⅛ inches in an original measured length of 6½ inches, the distance between markers on the sample being 7⅝ inches at the time the wire broke. In the case of an 80-meter fundamental antenna, this would give a total stretch of 280 inches. Why then measure to the fraction of an inch or test for the proper length? The first heavy wind or load of ice will give the antenna additional length.

With these thoughts in mind an investigation was made of the genuine "hard drawn" No. 12 copper wire. In the same test setup, the hard drawn wire showed a breaking strength of approximately 300 lbs. This wire showed a stretch of approximately 1/64 of an inch in the 6.5 inches between markers, when stretched to the breaking point of 300 lbs. If the hard-drawn wire is stretched up to a 150-lb. load, sufficient to break the magnet wire, the total stretch would be only approximately one inch, compared with 280 inches for the softer wire.

— John H. McAulay, W7BUX

—···—

Link Coupling to the Antenna Tuner

The gang here in Nevada are using a stunt which may be of considerable interest to others. W6UO at Yerrington, Nev., first tried the scheme on his t.p.t.g. 852 rig and it worked beautifully, so others of us have tried it with good results.

It seems to me that the proper place to terminate a pair of tuned feeders is at the point where they enter the building. This usually permits greater antenna height and precludes the possibility of r.f. feeding into power wiring, water pipes, etc. It is not always possible to place the transmitter exactly at the place where the feeders enter the building, however; in my case the transmitter is ten feet from the feeder terminus.

At W6AJP a single turn of wire around the cold turn of the output inductance and a single turn around the middle of the antenna tuning inductance are connected by a link of twisted lamp cord, as shown in Fig. 21. The twisted line has no external field and transfers more energy with less effect on tuning than the usual coupling coil. A small box mounted right at the point where the feeders enter the building contains the antenna tuning unit, with two series condensers, a parallel condenser, and the antenna coil of fourteen turns.

There seem to be so many advantages to this low-impedance coupling arrangement that many of the gang should try it. The twisted link can be run around picture molding, base boards, etc., since the length of the line doesn't affect its operation. For the experimenter, any number of transmitters can be built up using a common antenna tuning unit. With 100 watts output the r.f. voltage in the line is very low and the energy transfer is complete. With self-controlled rigs, critical coupling is eliminated, with greater stability and output. It is necessary, of course, that the antenna be of the proper length, otherwise r.f. will show in one or both of the twisted wires.

— Tom J. Boland, W6AJP

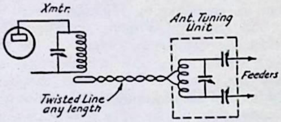


FIG. 21 — LINK COUPLING BETWEEN THE TRANSMITTER AND ANTENNA TUNING APPARATUS

This system eliminates variable inductive coupling and permits placing the antenna tuning apparatus at any convenient point.

—···—

Forced to do some soldering on the roof when his antenna lead broke off, W2BNJ saved the day (there was no way to heat a soldering iron on the roof) by using a can of Sterno bought at the local five and dime store. The joint to be soldered was held in the flame until hot enough to melt solder, which was then allowed to run in the joint. This worked on a cold winter day, and may help some hams who run into the same kind of emergency.

Raising a Sectionalized Tower

As everyone who has tried it knows, raising a mast of the order of sixty or eighty feet long in one piece is an awkward proposition, even though the radio club turns out *en masse* to help. One way of simplifying the job was devised by Dr. H. K. McWilliams, of Waller, Texas. His mast is 60 feet high, but the ease with which it went up leads him to believe that an 80 or 100-foot tower could be handled equally well.

The mast—actually a tower of square section, tapering from a width of 30 inches at the bottom to 4 inches at the top—was built complete on the ground, using "2×2's" as the corner members with lattice cross bracing. It was divided into three sections each approximately 20 feet long, the sections being bolted together with appropriate overlap. When finished, the three sections were unbolted and the two upper ones telescoped into the largest, or bottom, section. Since the total height of the "collapsed" tower was only about 20 feet, this was raised easily. The bottom section was then guyed at the top. By means of a ladder, pulleys were then fastened to the upper end of the middle section, ropes being run through the pulleys from outside the tower down through the middle section to ground, where the ropes were tied to the bottom of the inner section. Pulling on the ropes then raised the inner section up through the middle; when pulled up to the right height the ropes were fastened securely and the upper and middle sections bolted together. The two left-hand drawings in Fig. 22 illustrate this procedure. The pulleys were then moved to the top of the bottom section, the ropes fastened to the bottom of the second section, and the upper part of the tower pulled up into place and bolted.

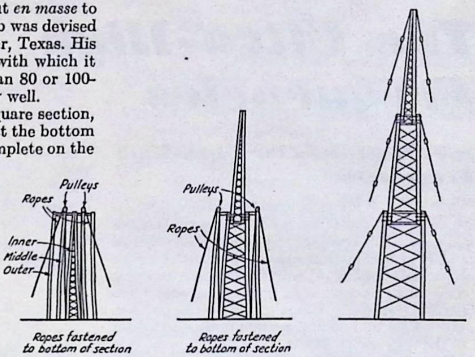

Pulleys
Ropes
Inner
Middle
Outer
Ropes fastened to bottom of section
Pulleys
Ropes
Ropes fastened to bottom of section

FIG. 22—RAISING A SECTIONALIZED TOWER BY MEANS OF ROPES AND PULLEYS

Guys are provided at each joint. Higher towers could be raised by providing additional 20-foot sections and following the same procedure. Dr. McWilliams' tower, although constructed of light material, has successfully withstood several Texas gales.

—···—

Here's a suggestion for a cheap lightning arrester from Lamar Allison, Emory, Va. Get a blown-out plug fuse (generally there are at least one or two around a ham station), screw into an ordinary porcelain lamp socket and mount on the window sill. Connect antenna and ground as with any other arrester. The gap in the fuse preferably should not be too great—a 64th of an inch will be about right—so pick out one that has been blown gently (!!).

9

The Ultra-High Frequencies

R.F. Indicators for Ultra-High Frequencies

WHILE conducting some tests on 56 mc., we found a real need for a very sensitive r.f. meter. The ordinary absorption meter caused a shift in oscillator frequency because of power drain and coupling; a neon tube also was unusable since small variations in power level aren't noticeable, especially during daylight. The problem was solved by building a vacuum-tube indicator of the type shown in Fig. 1.

It is essential that the grid-plate return be connected to the negative side of the filament since a slight negative bias is needed. If the instrument is to be calibrated for laboratory measurements, the filament voltage should be kept constant. Also, it would be necessary to put a potentiometer across the filament battery with the arm connected to the grid-plate return. The potentiometer is then adjusted for a small positive meter reading.

On our tests, we set the meter near the feeder input to the antenna and adjusted the oscillator and the antenna length for real efficiency. The same result was obtained by placing the meter near the antenna ends. Two sets installed in cars were similarly adjusted, while operating over a distance of about four miles, with the result that maximum signal strength was secured.

The pointer of the milliammeter will jump off scale if the unit is brought within four or five feet of a small unshielded oscillator. Its sensitivity and simplicity make it of real value.

— *E. E. Comstock, W3FKQ*

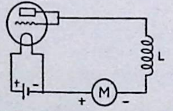


FIG. 1 — AN R.F. INDICATOR FOR ULTRA-HIGH FREQUENCY WORK

An instrument of this type is considerably more sensitive than ordinary meters or neon lamps, and introduces negligible loading in the circuit under measurement. The filament of the 30 is lighted by a single dry-cell or flash-light cell. The meter M is a d.c. microammeter or 0–1 milliammeter. L, the pickup coil, consists of a few turns of small diameter.

Another type of indicator which is particularly useful for locating standing waves on Lecher wires is suggested by Richard C. Elliot, of Tacoma, Wash. He writes as follows:

"For those ultra-high frequency enthusiasts who sometimes experience Lecher wire difficulties this little device, which I call a 'standing wave locator,' may be an aid. It came about in following Hull's[1] instructions on Lecher wire measurements. Because of the physical character of the oscillator and the work room, it was impossible to arrange the meters in a position where they could be read easily from the location of the Lecher wire. Consequently an adaptation of Professor Yagi's[2] method of measuring wavelength was made. The diagram is shown in Fig. 2.

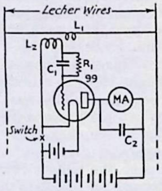


FIG. 2 — STANDING-WAVE LOCATOR

L_1 — 2 turns No. 18 wire spaced about 3/16 inch on a half-inch hard rubber tube the ends of which slide over the Lecher wires.
L_2 — 3 turns on same tube, spaced same as L_1.
C_1, C_2 — .003-μfd. fixed mica condensers.
R_1 — 7–10 megohms. May not be needed.
MA — 0–1 d.c. milliammeter or lower-range microammeter.

The hard rubber tube is about two inches long to accommodate Lecher wires having two-inch spacing.

"The apparatus, exclusive of the sliding wire and L_1 and L_2, can be put in a metal can or box, making it easily portable. The small-sized flashlight dry cells were used for plate and filament supply as they could be employed to fit in odd shaped cans and increase the flexibility and portability of the locator. Of interest perhaps is the high value assigned to the grid condenser C_1. This value was found to give the greatest dip in plate current when the sliding wire L_1 was at the peak of a voltage node. The node could be detected within a probable accuracy of five millimeters.

---

[1] Hull, Ross A. "Practical Communication on the 224-Mc. Band," *QST*, November, 1934.

[2] Yagi, Hidetsugu, "Beam Transmission of Ultra-Short Waves," *Proc. I.R.E.*, June, 1928.

"This method would also be useful in searching for unwanted standing-waves in transmission lines. Incidentally most of the parts are to be found in any ham's junk-box!"

* * *

Antenna Coupling to the 56-Mc. Receiver

Many hams on the u.h.f.'s spend a lot of time getting their transmitting antennas way up in the air or have elaborate directional affairs, but I wonder if they do the same for receiving? From observations in this locality I would say that there are very few fellows paying enough attention to it.

I am located in a valley, on sea level, one and a quarter miles from Long Island Sound, about forty miles air line from New York. With ordinary equipment, such as a super-regenerative receiver and a pair of 45s in transmitter, I think I'm having more fun per mile than a lot of fellows. My antenna is about 60 feet off ground. It is an 8-foot vertical with 44 feet spaced feeders going down into the shack. The same antenna is used for transmitting as receiving. Of course you can't duplex, but how many DX contacts on 5 are?

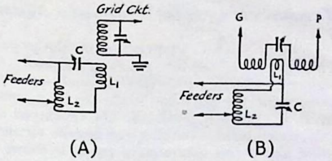


FIG. 3 — TUNED COUPLING FOR THE 56-MC. RECEIVER

L_1 — 3 turns No. 16 spaced 1/16th inch; coil diameter ½ inch.

L_2 — 6 turns No. 12 spaced 3/16th inch; coil diameter ½ inch.

C — 5-plate midget.

The circuit at A is for receivers having a single grid circuit coil; B for receivers using the split-coil circuit.

My fun started when I took advantage of a tuning scheme suggested by W1EYM, N. Bishop, shown in Fig. 3. It has worked well for all fellows who tried it. Make the receiving antenna just as high as the transmitting antenna — or use same one as we do around here. It makes the difference between no signals at all and signals of the S6 to S7 variety.

The feeders from the antenna are clipped on the circuit as shown. The clip on the 6-turn coil is set so that resonance will be obtainable at some setting of C, indicated by causing the receiver to stop regenerating. Signals will be best with C detuned just sufficiently to permit the receiver to return to the super-regenerative condition.

— *Ralph M. Bray, W1CDR*

* * *

Car Antenna Kinks

Many amateurs are confronted with the problem of trying to install a five-meter transceiver in a new car. I have one of the turret-top cars, which added to my troubles when working out the aerial problem.

The aerial itself is a factory-made telescope-type five-meter antenna, with four mounting holes very conveniently placed at the base. In these I placed four rubber suction cups, of the type one can buy at any automobile supply store. These make a very excellent support for the aerial. When wet these suction cups have an amazing strength and will resist the wind pressure very well.

By placing the aerial on the roof or any convenient place, the feed problem was very quickly overcome by the use of concentric feeders. For this I used low-capacity shielded wire, which works very well. This allows the transceiver to be placed anywhere in the car. Without marring the car in any way the aerial can be very easily and quickly put up and taken down. The connection of the concentric feed in my particular case was one and one-half turns from the cold end of the tank coil. Judging by reports, the aerial seems to be quite efficient.

— *John D. Woodlock*

* * *

Five-Meter Antenna for the Car

Needing a method of supporting a 56-Mc. vertical antenna on a car so that the

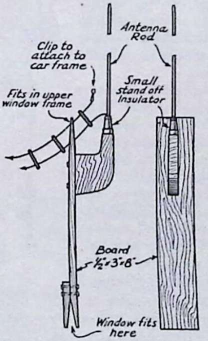

Antenna Rod
Clip to attach to car frame
Fits in upper window frame
Small stand off insulator
Board ½"x3"x8'
Window fits here

FIG. 4 — DEMOUNTABLE FIVE-METER ANTENNA FOR THE CAR

antenna would be readily demountable and not mar the car in any way, I devised the scheme diagrammed in Fig. 4. It worked very successfully, so I am passing it on to any of the five-meter gang who may be in the same predicament. The car window is cranked all the way down, the upper (sharpened) end of the flat wood piece is fitted in the groove where the glass usually goes, and the window is then cranked up into the groove in the lower end of the wood piece. For the antenna itself, a lath or bamboo flower stake supporting a wire would work just as well as the rod and standoff combination, which is not very strong in a wind. I use a 46-inch rod with six-foot feeders spaced two inches, a combination which works out well for mobile operation where trees are low over the streets. A small battery clip grounds the odd feeder to the metal rain gutter around the roof of the car.

— *Edgar V. Seeler, Jr., W1BDF*

—····—

Five-Meter Interference to BCL's

How one case of interference to a modern all-wave receiver from a five-meter transmitter was cured is described in the following letter from Martin Schwartz, W2EPZ. It may help others.

"For eight months this station has been actively engaged on five meters with a rig consisting of a 53 long-line oscillator, modulated by a Class-B 53. The antenna is a matched affair fed from a line eighty-five feet long. Input to the oscillator is 12 to 14 watts.

"Recently one of the sixty-eight tenants in the building purchased a new Philco Model 29X all-wave receiver. The interference from W2EPZ on this receiver was terrific — no place on the dial was clear of me and the volume was greater than any broadcast station.

"A check on the receiving antenna showed it to be but six feet away from the transmitting antenna and at the same height. Disconnecting the antenna from the receiver reduced the QRM to about 75%. It was decided to convert the antenna to a regular doublet, replaced in the same position. This change removed 90% of the interference. Success was in sight, so a pair of small hand-wound chokes of fifty turns each on a quarter-inch dowel was installed in each of the feeders at the receiver. This eliminated all of the QRM. The new antenna increased the selectivity and sensitivity of the receiver, and needless to say the owner was very greatly pleased. No ground was used."

—····—

Shorting Link

IN SHORTING the grid pipes in my stabilized five-meter oscillator, every system I tried only served to pull the pipes together or push them apart, thus throwing them out of parallel. However, I bought two 60-ampere fuse clips, five cents each, connected them with a piece of flexible copper strip, put them on the pipes, and there you are. The 60-ampere size gives a great contact on ⅝-inch outside diameter pipe.

— *Jack W. Turner, W3ERY*

—····—

Transceiver à la "Minute Man"

AN ADAPTATION of the popular "Minute Man" 56-mc. receiver, originally described in October 1935 *QST*, to make it into a transceiver for portable work has been made by B. P. Hansen, W9KNZ. The revamped circuit, which besides working well has the virtue of using about the minimum of parts, is shown in Fig. 5. Aside from following the specifications given, the constructor will find no special precautions necessary except the usual one of making all r.f. leads short. The various send-receive switches shown should of course all be on one handle — a triple-pole double-throw switch, in other words. The transformer *T* may be one of

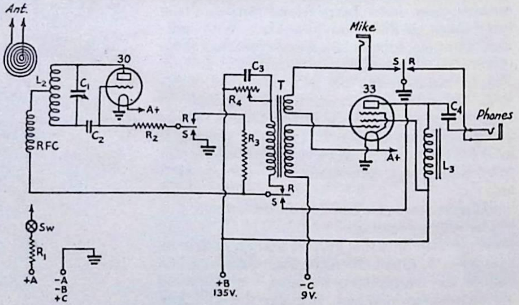


FIG. 5—"MINUTE MAN" TRANSCEIVER

C1 — Two-plate midget variable, low-loss.
C2 — 100 μμfd.
C3 — 0.25 μfd.
C4 — 0.1 μfd.
R1 — 3 ohms.
R2 — 10,000 ohms.
R3 — 5 megohms.
R4 — 50,000 ohms variable.
L1 — Four turns in flat spiral.
L2 — 10 turns No. 14, ½ inch inside diameter, spaced diameter of wire.
T — See text.
RFC — 45 turns No. 25 cotton-covered wire, inside diameter ¼ inch, close wound and self-supporting.

the kind made from transceivers or a home-brewed gadget of the type made by W9KNZ, who adapted a midget audio transformer by winding 300 turns of No. 32 wire over the other coils for the microphone.

The antenna used with the transceiver consisted of two wires each about four feet long. These can be cut more nearly to resonance in the band if desired. The antenna coil, L_1, should be moved around in relation to L_2 to give optimum coupling, as judged by reception. One good feature of the rig is that as a receiver the radiation seems to be negligible.

—···—

R.F. Amplifier for the "Minute Man"

A SUGGESTION for using a broadly-tuned r.f. amplifier with the "Minute Man" receiver also comes from W9KNZ, these amplifiers being in wide use among the Colorado five-meter gang as a means for preventing radiation. He writes:

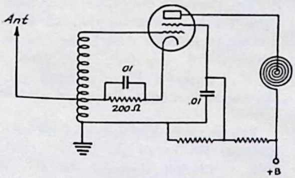


FIG. 6 — SELF-RESONANT REGENERATIVE R.F. STAGE FOR THE "MINUTE MAN" RECEIVER

The tap for cathode and antenna should be a few turns from the ground end — not far enough to permit the tube to oscillate.

"The r.f. stage is nothing but a 36 with conventional values. The only unconventional thing is the antenna being brought into the cathode tap and the fact that the cathode is tapped up on the grid coil a little to give some regeneration. The primary of the r.f. transformer (interstage) is the spiral pancake coil mentioned in the original article on this receiver (Oct. '35 *QST*). The r.f. socket must be placed so that the plate lead is of negligible length, and the cold end of the plate coil must be by-passed to ground by a good mica condenser through the shortest possible path. Slotting both the detector and r.f. tube bases between all pins also will help. Everything the original article said about the operation of this receiver still applies. The r.f. grid coil is made of No. 18 bell wire, 22 turns ½ inch in diameter, close wound. By varying the turns a little one way or the other the coil can be made to peak pretty well over the five-meter band."

The circuit is given in Fig. 6.

—···—

Two-Band U.H.F. Transceiver

FIG. 7 is the circuit diagram of a 5- and 2½-meter transceiver which has been used successfully by Eric W. Cruser, W2DYR. Its unique features are the elimination of the special audio-microphone transformer usually required by transceivers, and the provision of a method of monitoring the transmissions. W2DYR writes:

"The vital difference between this and the ordinary transceiver circuit is that no special combination mike and audio transformer is necessary so that the same tube may be utilized as both a modulator and audio amplifier. The circuit is simple and the parts required are of the variety that are usually found in a ham's junk box. The tubes used are a 56 oscillator-detector, and a 56 modulator-amplifier. 27's and 37's will undoubtedly give good results. However, on 2½ meters super-regeneration was only obtainable with certain tubes (evidently some of the newer models with solid plates and spiral heaters).

"To change from 'send' to 'receive' requires no more switching than in the ordinary transceiver, and a double-throw triple-pole jack-type switch does the whole job. Provision is made in the circuit so that the signal can be monitored while transmitting.

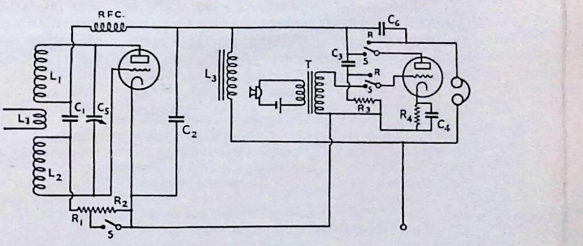


FIG. 7 — A TRANSCEIVER CIRCUIT WHICH REQUIRES NO SPECIAL TRANSFORMER

C_1 — 100 μμfd.
C_2 — .006 μfd.
C_3 — .01 μfd.
C_4 — 10-μfd. electrolytic.
C_5 — 5 meters: 20-μμfd. midget variable; 2½ meters: two half-inch copper discs mounted so spacing can be varied.

C_6 — 250 μμfd.
R_1 — 7000 ohms, 1 watt.
R_2 — 100,000 ohms, 1 watt.
R_3 — 300,000 ohms, 1 watt.
R_4 — 2500 ohms, 1 watt.
RFC — For 5 meters, 4 feet of wire wound on ¼-inch dowel; for 2½ meters, 2 feet of wire wound on ¼-inch dowel.
L_1, L_2 — 5 meters: 7 turns, ⅜-inch diameter; 2½ meters: 3 turns, ⅜-inch diameter.
L_3 — 1 turn, ⅜-inch diameter.
L_4 — 30-henry choke.
T — Single-button microphone transformer.

"When used on 2½ meters the tuning condenser which proved most satisfactory was one improvised from two small copper discs about ½-inch in diameter, one stationary and the other soldered to a screw and mounted so the distance between the two could be varied."

Condenser C_6 makes possible monitoring of the transmissions. A small amount of audio signal gets through C_6 to the 'phones, although with the small capacity specified the power consumed is so small as not to affect the modulation. C_6 has no effect on the operation of the set as a receiver.

The reader will be interested in some modifications which were later made by its designer, W2DYR, who wrote: "The revised circuit is given in Fig. 8. A 2A5 replaces the 27 modulator-amplifier in the 2.5-volt model and a 41 replaces the 37 for 6-volt operation. The biasing resistor was changed to 1000 ohms for these tubes. The grid leak used for transmitting was dropped from 7000 ohms to 5000 ohms, and for receiving from 100,000 ohms to 50,000 ohms. This made the rig operate with more stability on 2½ meters."

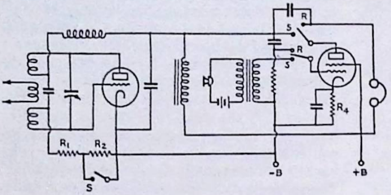


FIG. 8 — REVISED TRANSCEIVER CIRCUIT

The circuit, which requires no special transformer, is shown in its original form in Fig. 7 on page 123. Constants are the same except that R_1 is now 5000 ohms; R_2, 50,000 ohms; and R_4 1000 ohms. The audio tube is a power pentode.

BCL QRM from Five Meters

The following information was gathered after many experiments with BCL interference caused by 56-Mc. 'phone stations to receivers located on the same premises as the station but working from separate power supplies. I am passing it on with the hope that it may help others.

When the antenna was connected to the b.c.l. set the interference covered the entire broadcast band and did not appear to be tunable, but disappeared when the antenna was disconnected. Various methods of elimination were tried, including grid suppressors and bypass condensers, but while the interference disappeared so did the broadcast program.

Finally a wave trap using a 20-μμfd. midget variable condenser shunted with three turns of bus bar wound to a diameter of ½ inch with turns spaced the diameter of the wire was tried and when tuned to the frequency of the station completely eliminated the interference.

This trap was inserted in series with the antenna lead-in of the b.c. set, but the lead from the trap to the set, while only 6 inches long, was sufficient to pick up the interference. This lead should be shielded and the shielding grounded to the chassis of the set.

This idea was tried on a completely shielded 10-tube receiver of the tuned-r.f. type and it completely eliminated all interference, except that on WABC it appeared to ride in on the carrier. However it was just barely understandable when no modulation was applied to the carrier of the b.c. station.

— *C. M. Spengler, W2BXW*

INDEX

PAGE
A.C. Generators from D.C. 96–97
Absorption Condenser Microphone 54–55
Alcohol Lamp 7
Aluminum, Cutting 7–8
Aluminum Paint, Removing 12
Amplifier, for Regenerative Receivers 29
Amplifier, U.H.F. R.F. 123
Amplifiers, Microphone 50–52
Amplifiers, Preventing Oscillations in R.C. 50
Analyzer, Multi-Purpose 81–82
Antenna Harmonic Traps 36–37
Antenna Systems:
  A Sleet Melting Antenna 112
  A Three-Feeder Double-Antenna System 117–118
  Adjustable-Length Antenna 113–114
  An Unorthodox Antenna 111–112
  Antenna Rotating Device 115–116
  Antenna Coupling to the 56-Mc. Receiver 121
  Antenna Directivity 114–115
  Antenna Pruning for Efficiency 112–113
  Antenna Supports 105
  Car Antenna Hints 121
  Changing Antenna Directivity 115
  Changing the Antenna Directional Characteristics 114
  Five-Meter Antenna for the Car 121–122
  Guying Antenna Masts 105–106
  Half-Wave Hertz for Receiving 109–110
  Hard-Drawn vs. Soft Copper Wire 118
  Inexpensive Feeder Separators 108
  Improving the Performance of the Voltage-Fed Hertz 107
  Kink for Using Single-Wire End-Fed Antennas 110
  Lightning Arrester 119
  Link-Coupling to the Antenna Tuner 118
  Remote Switch 107–108
  Sectionalized Tower 119
  Some Zepp Pointers 110–111
  The Twisted-Pair Feeder Transmitting Antenna for Receiving 109
  Tuning the Receiving Antenna 116
  Twisting Heavy Guy Wires 106
  Voltage-Fed Antenna with Twisted-Pair Feeders 108–109
Anti-Blinker 103–104
Audio Oscillators 69–70, 70–71, 71–72, 75–76
Audio Output Stage for Regenerative S.S. Receiver 23–24
Audio Selectivity 19, 21–22, 28–29
Audiometer 28
Automatic Battery Switch for Microphone 53
Automatic Carrier Switching 56–57
Automatic Tone Control 20–21

B.C.L. Interference (*see* Interference Elimination)
Band-Spread 28-Mc. Coils 22–23
Band-Spread and General Coverage Coils, Calibrated 19–20
Battery Grid Bias 102
Battery-Operated Portable Transmitter 31–32
Bias Protection 38
Bias Supplies 91–93
Blanketing, Cure for 67

PAGE
Blinking, Cure for 103–104
Blocked-Grid Keying 60, 62
Break-In:
  Break-In Plus Monitored Keying 71
  Break-In and Monitoring System 72–73
  Break-In Monitor 74
Bridge, Impedance 82, 83
Broadcast Interference, Eliminating 67–68
Bug, Home-Made 76
Bug, Sliding Weights 76

Calibrated Band-Spread and General Coverage Coil 19–20
Calibrating and Receiver for General Coverage 20
Calibration Curve, Spreading Out 80
Caliper Coupling 34
Car Antennas 121–122
Carrier Switching, Automatic 56–57
Choke-Coupled Modulation of R.F. Pentodes 48
Chokes, Insulating Filter 88–89
Class-C Audio Amplifier 21–22
Clicks, Eliminating Key 66–67
Clips, Inductance 6–7
Coil Winding Kinks 5–6
Coils:
  28-Mc. Band-Spread Coils 22–23
  Calibrated Band-Spread and General Coverage with the Same Coil 19–20
  Caliper Coupling 34
  Clips 6–7
  Forms 12
  Quick Amplifier-Doubler Shift Coil 37
  Soldering Coil Form Prongs 9
  Tapping Transmitter Coils 6–7
  Threaded Forms 8–9
  Variable Antenna Coupling 34–35
  Winding Coils 5–6, 9–10
Color Code, Resistor 13
Condenser Microphone, Absorption Type 54–55
Condenser Microphone, Head Amplifiers 50–52
Condensers, Neutralizing 11
Condensers, Home-Made Tank 12
Converter, 6F7 18–19
Converter, Stabilizing 2A7 18
Copper Tubing, Cleaning 13
Coupling, Variable Antenna 34–35
Crystal Control (*see* Transmitting)
Crystal-Lock Circuits 34, 41–43
Crystals:
  An Inexpensive Temperature Control Oven 45
  Home-Made Temperature Control Box 46
  Improving Crystal Stability 43–44
  More on Silvering Crystals 44–45
  Speeding Up Rough Grinding 41
  Tube-Base Crystal Holders 40–41
Cutting Aluminum 7–8

D.C. 110-Volt Transmitter 30–31
D.C. 32-Volt Plate Supplies 89–100
D.C. Generators to A.C. 96–97
D.C. Receiver 14–15
Decibels, Volume Control Calibrated in 52–53
Decoupling Circuits, R.F. 58
Delay Switch for Power Supplies 87

PAGE
Detector, Improving Stability 17
Directional Antennas 114–116
Double-Antenna Three-Feeder System 117–118
Doubler, Regenerative 37–38
Drilling Lubricant 13
Duplex 'Phone 57–58
Duplex Power Supply 90–91

Economical Filter Arrangement 94–95
End-Fed Antennas, Adjusting 111, 112–113
Excitation-Failure Protection 95
Experimental Universal Power Supply 93–94

Feeder Separators 108
Feeders, Twisted-Pair with Voltage-Fed Antenna 108–109
Feeders, Twisted-Pair for Receiving 109
Filament-Voltage Booster 90
Filament Voltage Regulator 89
Filter Chokes, Insulating 88–89
Filter, Economical 94–95
Five-Meter Antenna for the Car 121–122
Five-Meter Receiver Antenna Coupling 121
Fly-Power 'Phone Transmitter Using 6A7 32–33
Frequency Measurement:
  Extending the Freqmeter Calibration 78
  Finding the 28-Mc. Band 78–79
  Freqmeter Calibration from B.C. Stations 77
  Freqmeter-Monitor with Dual Purpose Tube 79
  Identifying the Freqmeter Signal on a Super 78
  Measuring Small Frequency Differences 85–86
  Single-Tube E.C. Freqmeter-Monitor 79–80
  Spreading Out that Calibration Curve 80
  Spotting Frequencies 77–78
Fuses, Home-Made 87–88

Generators, A.C. from D.C. 96–97
Generators, Voltage Regulator for 97
Grid Bias, Battery 102
Grid Bias Supplies 91–93
Grid Keying 60–62
Grid-Leak Bias with Automatic Protection 38
Grid Leak Modulation 47
Grinding Crystals, Speeding Up 41
Guying Antenna Masts 105–106

Hard-Drawn vs. Soft Copper Antenna Wire 118
Harmonic Suppression 36–37, 38–39
Hartley Crystal-Lock Oscillator 42
Head Amplifiers 50–52
Hertz, Half-Wave, For Receiving 109–110
Hertz, Improving Performance of Voltage-Fed 107
Hum, A Cure for Receivers 23
Hum, Checking 59
Hum Modulation, Eliminating 102

Impedance Bridge 82–83
Indicating R.F. at U.H.F. 120–121
Inductive Neutralization 35–36
Interference Elimination:
  A Cure for Blanketing 67
  Five-Meter Interference to BCL's 124
  Parasitics and Interference 68–69
  Washing Out B.C. Interference 68
Isochrometer 85–86

Jacks, "Shockless" 87

Keying:
  A Clickless Keying System 66–67
  A Different Keying-Tube Circuit 65
  Blocked-Grid Keying 60, 62
  Chirpless Keying with Pentodes 60–61
  Crystal Oscillator Keying 63
  Eliminating the Keying Relay Battery 65–66
  Grid Keying with Bias Supply 61–62
  Home-Made Bug 76
  Keying Oscillators 72–75
  Keying-Relay Circuit Clicks 66
  Keying the E.C. or Tri-Tet Oscillator 64
  Keying the Link Circuit to Prevent Clicks 61
  Key Thump Kinks 67
  Improved Keying-Tube Circuit 65
  Oscillator Keying with Grid Leak Bias On Amplifiers 63
  RK-20 Keying Circuits 61
  Sliding Bug Weight 76

Lamp, Alcohol 7
Lamp, Test 11
Lightning Arrester 119
Linear Amplification with Suppressor Modulation 48–49
Link-Coupled TNT Amplifiers 39, 40
Link Coupling to Antenna Tuner 118
Link, Shorting 122

Machining Aluminum 8
Magnets for Velocity Microphone 53–54
Masonite Panels, Finishing 13
Mast, Sectionalized 119
Masts, Guying 105–106
Meters:
  Measuring Power with Wattmeter 102
Metering Several Stages 88
  Modulation Meter 56
  Modulation Monitor 82
  Multi-Metering the Transmitter 101–102
  Multi-Purpose Analyzer 81–82
  Output Meter 82
  Repairing Milliammeters 13
  "Shockless" Meter Jacks 87
  Using a Voltmeter as an Ohmeter 84–85
  V.T. Voltmeter 55–56
Microphone Battery Switch 53
Microphone Pre-Amplifiers 50–52
Microphones:
  Absorption Condenser Microphone 54
  Automatic Microphone Battery Switch 53
  Magnets for the Velocity Microphone 53–54
Midget Portable Receiver 14
Milliammeter Switching 39
Mixing System 53
Modulation:
  6E5 for Checking Overmodulation 57
  Checking Modulation Quality 59
  Choke-Coupled Modulation of R.F. Pentodes 48
  Grid Leak Modulation 47
  Modulation Meter 56
  Plate Modulation with Tapped Choke 47–48
  Suppressor Modulation with Linear Amplification 48–49
Monitoring:
  Audio Oscillator Keying Monitor Without Relays 75–76
  "B" Power for the Keying Oscillator 71
  Break-In and Monitoring System 72–73
  Break-In Monitoring 74
  Break-In Plus Monitored Keying 71
  Continuous Monitoring with the Regenera-

PAGE

  - tive S.S. Super........ 73–74
  - Freqmeter-Monitor with Dual-Purpose Tube. 79
  - Modulation Monitor........ 82
  - Monitoring Audio Oscillator with Keyer Tubes 70–71
  - Monitoring Kink........ 74
  - Monitoring Without a Monitor........ 74
  - 'Phone Monitor........ 55–56
  - 'Phone Monitor and Modulation Meter..... 56
  - 'Phone Monitor Using 55........ 59
  - Relayless Monitoring........ 70
  - Simple Keying Oscillator........ 71–72
  - Single Control of Transmitter, Receiver and Monitor........ 75
  - Single-Tube E.C. Freqmeter-Monitor....... 79–80
- Motor-Generator Voltage Regulator........ 97

- Neon-Bulb Audio Oscillators........ 69–70
- Neutralization, Inductive........ 35–36
- Neutralizing Condensers........ 11
- Neutralizing the Buffer........ 36
- Neutralizing the Final........ 36

- Ohmeter, Using Voltmeter As........ 84–85
- Oscillator-Mixer Coupling with 6F7........ 18–19
- Oscillators, Audio........ 69–70
- Output Meter........ 82
- Overload Protection........95–96, 104

- Panels, Finishing........ 13
- Parallax, Curing........ 11–12
- Parasitics and Interference........ 68–69
- Pentodes, Modulation of R.F........ 48–49
- Phone (*see* Radiotelephony)
- Photographic Recorder........ 83–84
- Plate Modulation with Tapped Choke........ 47–48
- Portable Power Supply........ 97–98
- Portable Receiver........ 14
- Portable Transmitters:
  - 75-Meter 'Phone........ 32
  - Battery-Operated Portable........ 31–32
  - "Fly-Power" 'Phone Using 6A7........ 32–33
- Power Supply
  - A.C. from D.C. Generators........ 96–97
  - Anti-Blinker........ 103–104
  - Battery Grid Bias........ 102
  - Boosting Voltage........ 89
  - Combination Time Delay and Bias Supply.. 93
  - Combined Plate and Bias Pack........ 91
  - Economical Filter Arrangement........ 94–95
  - Eliminating Hum Modulation........ 102
  - Filament Voltage Regulator........ 89
  - High Voltage from 32 Volts D.C........ 98–99
  - Home-Made High-Voltage Fuses........ 87–88
  - Home-Made Overload Relay........ 104
  - Inexpensive Fuses........ 87
  - Insulating Filter Chokes........ 88–90
  - Junk-Box Voltage Regulator for the M.G.... 97
  - Measuring Power with Wattmeter........ 102
  - Metering Several Stages........ 88
  - Overload Protection........ 95–96
  - Portable Power Supply........ 97–98
  - Power Supply Delay Switch........ 87
  - Power Supply for Multi-Stage Transmitters.. 90–91
  - Rectifier Switching for Voltage Changing.... 89–90
  - Reducing Power........ 103
  - Safe Starting and Excitation-Failure Protection........ 95
  - Self-Regulating Bias Supply........ 91–93
  - Simple-Filament-Voltage Booster........ 90

PAGE

  - Transformerless Plate Supplies........ 100–101
  - Transmitter Power from 32 Volts — Another Design........ 99–100
- Pre-Amplifiers........ 50–52
- Pre-Selectors........ 25–26
- Protective Devices........ 95–96
- Push-Push and Push-Pull Output Circuit....... 37

- QRM (*see* Interference Elimination)
- QRP Transmitter with 12A7 Tube........ 30

- R.F. Amplifier, U.H.F........ 123
- R.F. Indicators at U.H.F........ 120–121
- Racks, Relay........10–11, 12
- Radiotelephony:
  - A Simple Volume Indicator........ 55
  - A.C.-Operated Pre-Amplifier........ 51
  - A.C. Pre-Amplifier for Condenser Mike..... 51–52
  - Automatic Carrier Switching........ 56–57
  - Automatic Microphone Battery Switch..... 53
  - Checking Hum or Modulation Quality...... 59
  - Choke-Coupled Modulation of R.F. Pentodes 48
  - Duplex 'Phone........ 57–58
  - Grid Leak Modulation........ 47
  - Magnets for the Velocity Microphone...... 53–54
  - Mixing System........ 53
  - Modulation Monitor........ 82
  - Note on Decoupling Circuits........ 58
  - 'Phone Monitor and Modulation Meter..... 56
  - 'Phone Monitor Using 55........ 59
  - 'Phone Monitor — V.T. Voltmeter........ 55–56
  - Plate Modulation With Tapped Choke...... 47–48
  - Preventing Oscillation in R.C. Amplifiers.... 50
  - Single-Tube Head Amplifier for Condenser Microphone........ 50
  - Suppressor Modulation With Linear Amplification........ 48–49
  - The 6E5 for Checking Overmodulation...... 57
  - The Absorption Condenser Microphone...... 54–55
  - Volume Control in Terms of Decibels....... 52–53
- Receiving:
  - 28-Mc. Band-Spread Coils........ 22–23
  - A Cure for Receiver Hum........ 23
  - A Novel D.C. Receiver........ 14–15
  - A Simple Audiometer........ 28
  - A Single-Tube Model........ 25–26
  - An Audio Output Stage for the Regenerative S.S. Receiver........ 23–24
  - An Effective Regeneration Control........ 16–17
  - Audio Amplifier for Regenerative Receivers.. 29
  - Automatic Tone Control........ 20–21
  - Building Pre-Selectors........ 25
  - Calibrated Band-Spread and General Coverage with the Same Coil........ 19–20
  - Calibrating the Receiver for General Coverage 20
  - Further Dope on the Tapped-Coil Detector.. 15–16
  - Improved Regeneration Control for the Screen-Grid Detector........ 16
  - Improving Detector Stability........ 17
  - Improving Selectivity in the Regenerative Receiver........ 19
  - Increasing C.W. Selectivity........ 28–29
  - Increasing I.F. Selectivity by Regeneration.. 17–18
  - Midget Portable Receiver........ 14
  - Oscillator-Mixer Coupling with the 6F7...... 18–19
  - Output Meter........ 82
  - R.F. Amplifier for Five Meters........ 123
  - Regenerative Amplification at Signal Frequency........ 25–28

PAGE

[illegible] Detector Coupling 16
[illegible] 2A7 Converter 18
[illegible] Applied to Re-
[illegible] ... 21–22
[illegible] ... 122–124
[illegible]g, [illegible] 120–121
[illegible]der, [illegible] 83–84
R[illegible] 16–17
[illegible]
[illegible] Amplifi[illegible]
[illegible]ative Doubler..
[illegible]elays Racks..........
Relays:
  Eliminating the Keying-Relay Battery...
  Keying-Relay Circuit Clicks..........
  Home-Made Overload Relay........
  Overload Protection........ 95–96
Resistance-Coupled Amplifiers, Preventing Oscillation in........ 50
Resistor Color Code........ 13
Rotating the Antenna........ [illegible]
Screen-Grid Detector Coupling........ 16
Screen-Grid Regenerati[illegible] 16
Selectivity, Impro[illegible] .... 17–[illegible]
[illegible] in Regenerative Rec[illegible] 19
[illegible]easing C.W...... ... 28–[illegible]
[illegible] Feeder........ .....
[illegible] Crystals... .... [illegible]–45
[illegible]eratio[illegible]
[illegible]g In[illegible]
Stability, Improving Detec[illegible]...
Stabilizing 2A7 Converter........ 18
Suppressor-Grid Keying........ 61, 64
Suppressor Modulation with Linear Amplification 48–49
Switching 53 Sections........ 36
[illegible]ing the Antenna........ 107–108
[illegible] the Milliammeter........
[illegible] Modulation........ 47–48
[illegible]........ 15–16
[illegible] 45–46
[illegible]........
[illegible]........
[illegible]........ 67
[illegible]........ 95
[illegible]........ 39–40
[illegible]........ 34
[illegible]........ 20–21
[illegible]........ 119
[illegible]..... 100–101
[illegible]... 30–31
[illegible]
[illegible] 35–36
[illegible] 38
[illegible] 31–32
[illegible] 34
[illegible] 42
[illegible] 40

PAGE

"Fly-Power" 'Phone Transmitter Using a 6A7........ 32–33
Harmonic Suppression........ 38–39
Improving Crystal Stability........ 43–44
Link-Coupled TNT Amplifiers........ 39–40
"Locked" Amplifiers........ 41
Milliammeter Switching for Grid and Plate Circuits........ 39
More Locked Oscillator Circuits........ 42–43
Neutralizing Final........ 36
[illegible]alizing Kink........ 36
[illegible] Mc. C.C. Transmitters........ 33–34
[illegible]l Ap[illegible]n of Crystal-Lock System. 41–42
[illegible]........ 32
[illegible] or Doubling... 37
[illegible]........ 37–38
[illegible]ve Q[illegible]nsmitter... 30
S[illegible]........ 36
[illegible]NT [illegible]........ 34
Transceivers [illegible]........ 122–124
Variable [illegible]........ 34–35
Wi[illegible] the [illegible] 36–37
Tr[illegible]ing Antenna f[illegible] 109
Transceivers.......... 123–124
Traps [illegible]mitter Harm[illegible]..... 36–37
[illegible]-Base Crystal [illegible]........ 40–41
Tubes with [illegible] Bases........ 12
[illegible] Receiving Antenna.. 116
[illegible]-Meter C[illegible]........ 33–34
Twisted-P[illegible] Voltage-Fed Antennas 108–109
[illegible]-Feeder System........ 117–118

[illegible] Frequencies:
  [illegible] Coupling to the 56-Mc. Receiver... 121
  [illegible] from Five Meters........ 124
  [illegible]tenna for the Car........ 121–[illegible]
  Five-Meter Interference to BCL's........ [illegible]
  R.F. Amplifier for the "Minute Man"...... 123
  R.F. Indicators........ 120–121
  Shorting Link........ 122
  [illegible]"........ 122–123
  Two-Band U.H.F. [illegible]........ 123–124
Universal Experimental Power Supply........ 93–94
Unorthodox Antenna........ 111–112

[illegible] Voltmeter........ 55–56
[illegible]locity Micro[illegible] for........ 53–54
[illegible] Antenna, Adjustable........
V[illegible]........ 89, 90
Voltage Ch[illegible]........ 89–90, 103
[illegible]ge Doubling........ [illegible]
V[illegible] Filament........ [illegible]
V[illegible] Generator........ 97
V[illegible]ing Performance... 107
Voltmeter[illegible]........ 84–85
Volume Contr[illegible]........ 52–53
Volume Level In[illegible]........

Wattmeter, Measuri[illegible]..... 102
Winding Coils...... 9–10
Wire, Hard-Drawn vs. ....

Zepp Antenna Universal J[illegible] 106–107
Zepp Pointers........ ...

RUM[illegible] PRESS
CO[illegible]RD, N. H.